JULY, 1955

L 13 1955

PIPE LINE INDUSTRY

Gulf Publishing Company

CONSTRUCTION • OPERATIONS • MAINTENANCE

Noise-Controlled Compressor Station Inside Los Angeles

The problem was to design a compressor station that could operate in a rapidly growing residential section of Los Angeles. For how it was solved, turn to Page 20.

also . . .

Crude Flow to Generate Power . . 26
Why Branch Connections Fail . . . 32
Five Ways to Avoid an Ulcer 46

Turn page for additional contents and a Quick Review of this issue

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.P5

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JUL 13 1955

PIPE LINE INDUSTRY

CONTENTS and Quick Review

July, 1955 Vol. 3, No. 1

To help you put first things first, scan these time-saving digests, checking ☑ those you want to read first.

Noise-Controlled Compressor Station Within a Residential Area

☐ Southern California Gas Company faced the ever-present noise problem when they began plans to build a compressor station in a heavily-populated and rapidly-growing residential area of Los Angeles. In this area, it was more important than ever to study the acoustical characteristics of the station with effective noise-control measures the objective. The designers went to work and incorporated many new noise-reducing ideas into the plans.

By Raymond C. Baird.....Page 20

Crude Flow Over Andes to Generate Power!

☐ "Why waste the energy," reasoned the designers of a proposed pipe line over the Andes mountains of Bolivia. The line will drop 15,000 feet within a total distance of 48 miles. Present plans call for the crude to be routed through turbines to generate electricity.

By Anthony Gibbon.....Page 26

Pioneering the Opposed-Piston Diesel in Pipelining

☐ The compact two-cycle opposed-piston diesels, used for years on seagoing craft, have been adapted to pipe line use. Southeastern Pipe Line Company has operated six of them for 56 months. This is a report on what they have found out.....Page 28

Comparing Costs of Gas and Oil Fuels

☐ Use this handy chart to compare the costs of oil and gas fuels. Unit volume cost and gravity of oil are all the data needed to determine and equivalent BTU cost.

By Frank E. Hangs.....Page 31

Why Branch Connections Fail

☐ How good are encirclement saddles? How do tees compare? Pressure pulsation tests of branch connections have produced some surprising results. This article is a must for all designers.

By A. R. C. Markel, H. H. George and E. C. Rodabaugh.....Page 32

The Meter of the Future Is Here

☐ This new type analog computer calculates volumes from differential and static pressures, temperatures and specific gravity. It records and totalizes in gpm and cpm.

By Frank C. Smith, Jr.....Page 39

Operation Teakettle—Cooling Engines With Boiling Water

☐ Running internal combustion engines at a higher but more uniform temperature offers possibilities to the gas transmission industry. Engine heat is transferred at the boiling point of coolant water. Uniform engine wall temperatures, improved operation, and lower equipment and operating costs are the promised results.

By Brock Mott.....Page 42

How duPont Cures 65% of Its Alcoholic Cases

☐ The extent of alcoholism is now recognized as a major industrial medical problem. Here's a program—based upon sympathetic interviews, firm enforcement, and cooperation with Alcoholics Anonymous—that has yielded results beyond expectations. Cures were reported in 65 percent of the cases.

G. H. Gehrmann.....Page 44

Five Ways to Avoid an Ulcer

☐ Management men are under constant pressure to make decisions. Here are some hints on how to lessen the "ordeal" by going about it in a systematic and foolproof manner.

By Auren Uris.....Page 46

How to Write Good Letters

☐ Writing a good letter is a matter of being brief, modern, friendly. A good business letter can be a powerful instrument for you and your company. Page 48

Washday at El Paso Natural

☐ Many old gas transmission lines with long service records have accumulated large quantities of internal deposits. El Paso Natural Gas Company, which has tried virtually all cleaning methods in the past eight years, has found that washing down with a detergent solution is the best answer to the problem. Results are higher efficiencies, savings in pump horsepower (this has more than paid for the cleaning), and increased capacity.

By Clinton McClure.....Page 49

Coal Pipe Lines—A More Competitive Price With Oil and Gas Fuels?

☐ The first major coal-hauling pipe line is scheduled for completion late this year. For wrap-up of this important development and a look at other timely topics, read the **Changing Panorama**.....Page 55

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PIPE LINE INDUSTRY published every month. Entered as second class mail matter July 9, 1954, at the post office at Houston, Texas, under the act of March 3, 1879.

Suppose You Didn't Have Them!

We were listening to a report on what happened to oil field supply store profits in 1954 and prior years, during the June meeting of the Petroleum Equipment Suppliers Association, when suddenly the thought came to me:

"Suppose we didn't have any supply stores?"

It seems that year by year the expense of operating supply stores all over the U.S. has been increasing and the margin of profit becoming less and less, until in 1954 the average profit of 21 supply companies after taxes was only 2 percent. Each year for the past several years the profit has been dwindling, and of course for supply companies to earn an average of only 2 percent means that many supply stores are operating at a decided loss.

No wonder the supply boys were worried.

But suppose we didn't have any supply stores!

•

We have no record of when the first supply store was opened but we do know that one large supply company has been operating under the same name for 93 years. We have become so accustomed to seeing the supply stores move in with the drilling and production men that we simply take them for granted. And we suspect that in our busy daily life most of us have failed to give them the credit they are due in our oil production picture.

The average supply store in an active area will stock many thousands of items. The average investment in stock in a supply store will run $198,000. These are not imaginary figures. They come from the supply companies' reports themselves.

What a headache if the operators in, say, the Harvey, Louisiana, area, had to do without supply stores!

Here is some of what *would* happen if we didn't have supply stores:

• Everyone, big company and little operator alike, would have to provide his own warehouse of some kind. Some would be tiny, some would be large, and the total investment in land, buildings, stock (remember that $198,000) would be tremendous, and an increased warehouseman payroll would be a big item.

• But, you say, in that event the manufacturer would have to stock the items. All right, suppose he does. If he did, wouldn't your costs go up as a result of the manufacturer carrying such stocks?

• It would mean establishing credit arrangements for thousands of operators with hundreds —almost 1000—manufacturers.

• In many instances it would mean that delivery equipment would have to be provided for the smaller operator who possibly does not now have it in operation. Certainly delivery is one of the expenses we heard mentioned which the supply man would like to eliminate.

•

Of course there is no likelihood that the oil industry in the U.S.A. will suddenly or in any other manner, be deprived of the service of supply companies and their ready emblem of service—the supply store, but the report of the committee on "How Are We Doing" should remind us how fortunate we are to have them.

No, we are not going to lose our supply stores but they will have to make more profit to keep up their past and present good service.

Ray L. Dudley

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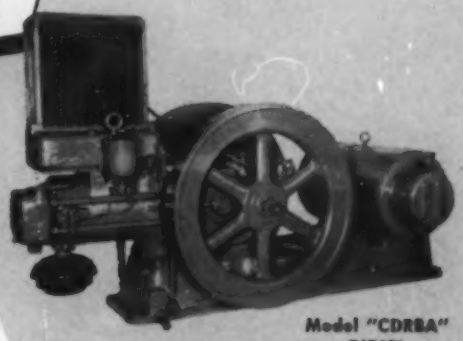
for your microwave communications



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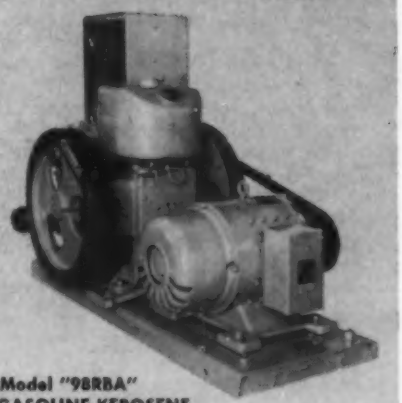
"ADRBA"	Diesel	1,500	5.5	1,800	3.0
"LDRBA"	Diesel	1,350	8.6	1,800	5.4
"BDRBA"	Diesel	900	7.8	1,800	4.9
"CDRBA"	Diesel	750	12.2	1,800	7.7

RATINGS BASED ON 24-HOUR-A-DAY OPERATION



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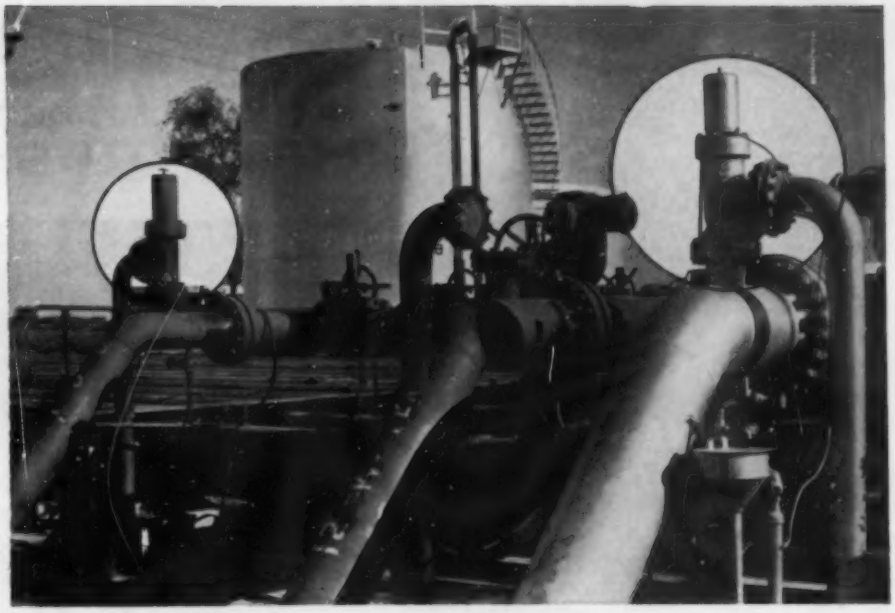

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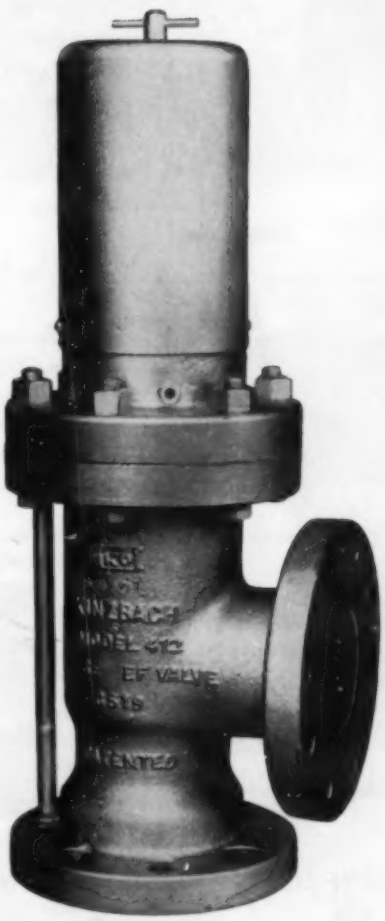

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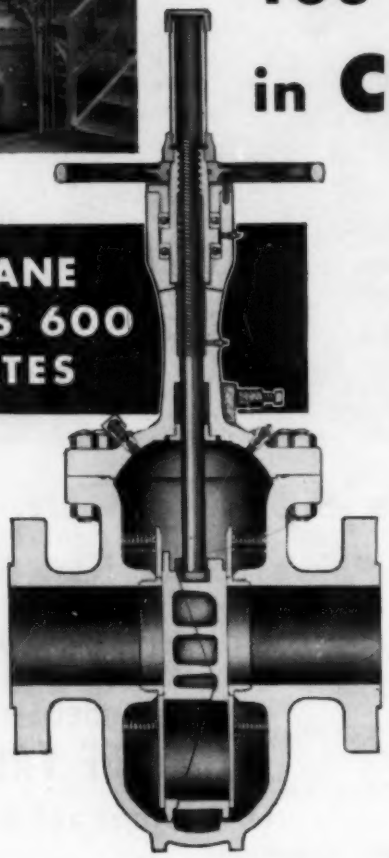

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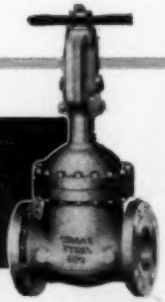

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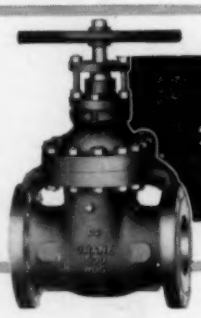

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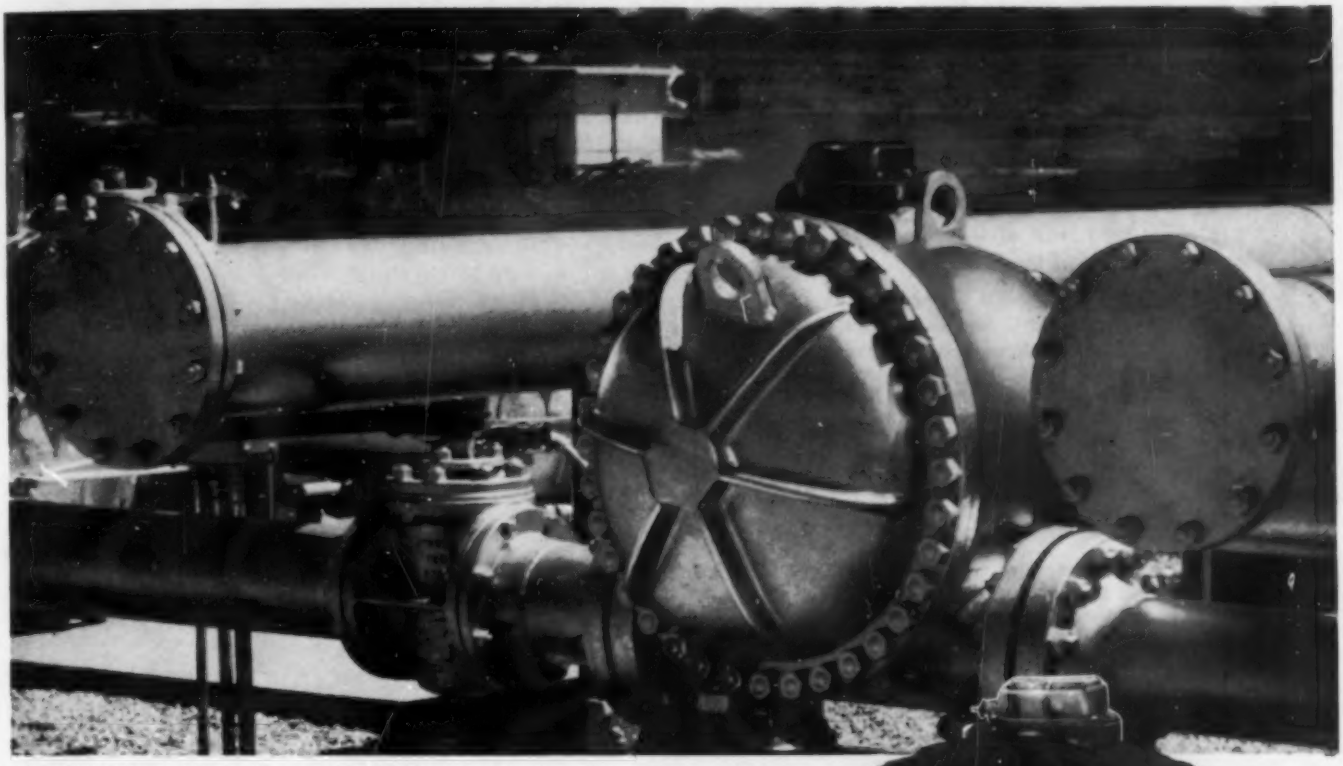

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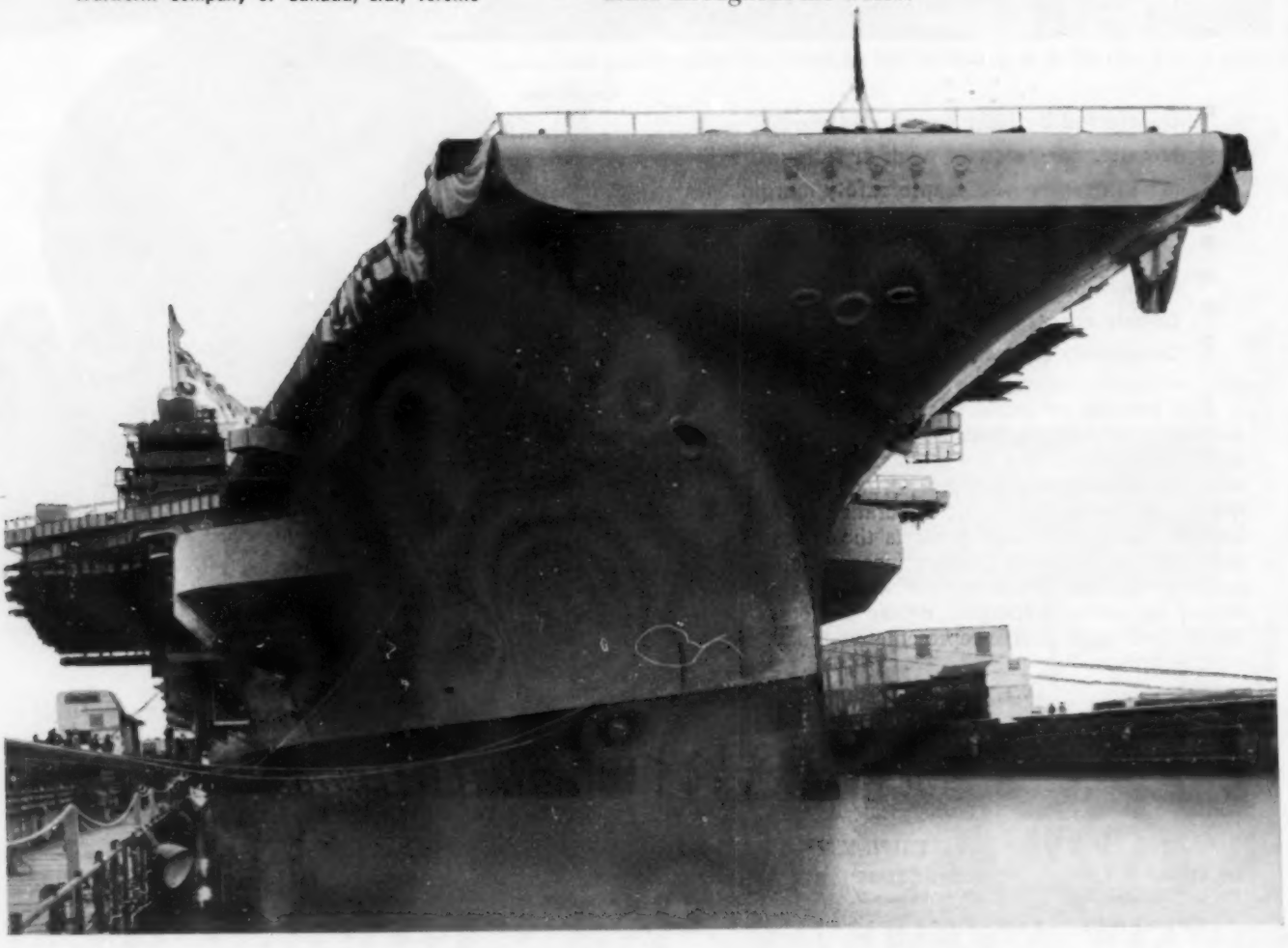

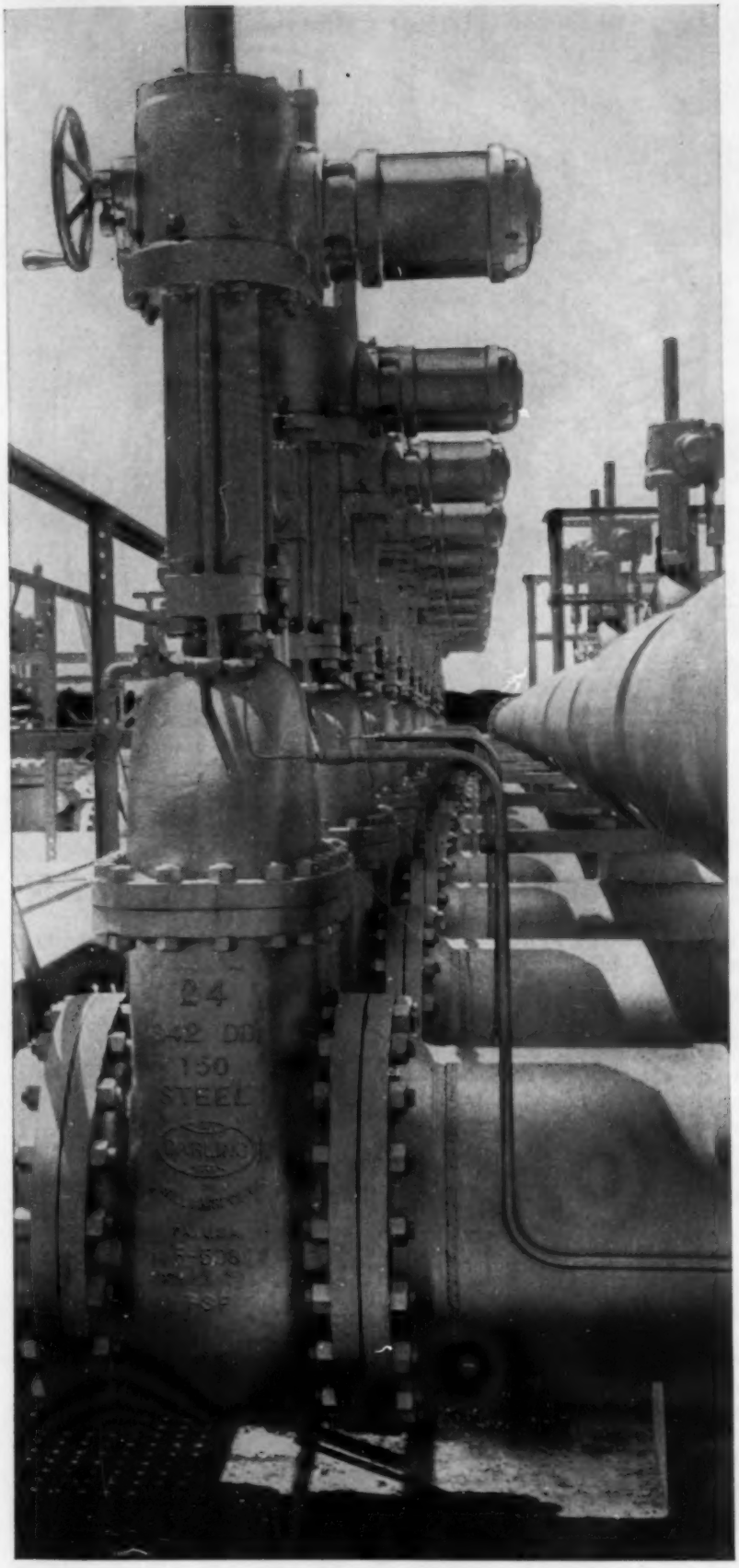

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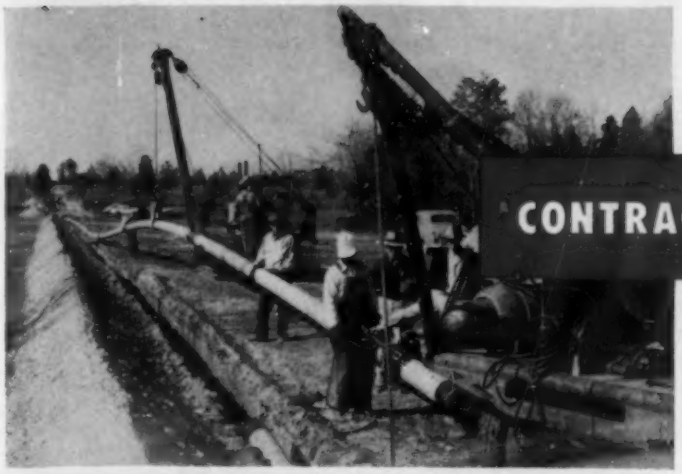

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The photographs on this page show construction activities along an 8⅝" pipe line in southeast Louisiana and southwest Mississippi. Note how easily and safely the J&L line pipe takes the bends. Contractors like to work with it, and owners like the extra service dividends.

J&L PIPE

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A finish welder at work on a joint of 10¾" O.D. National Seamless Bendin

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22,000 tons of NATIONAL SE

Coated and wrapped pipe being laid in preparation for back filli Welder

Bending and welding 10¾" O.D. National Seamless for a creek crossing.

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AL SEAMLESS Line Pipe

Welders and wrappers at work on a portion of the 10¾" O.D. main line.

THE Southeast Alabama Gas District, consisting of 24 communities, will be served by a 330-mile "U" shaped system of USS National Seamless Line Pipe, designed by Goodwin Engineers, Inc., of Birmingham, Alabama.

The new main line ties into Southern Natural Gas Company's line approximately 12 miles south of Montgomery. It runs south to Brantley, then turns eastward at Andalusia and continues through Enterprise to Dothan. From Dothan it runs north and ties back into Southern Natural's line a few miles south of Opelika, Alabama.

The total 22,000 tons of pipe were made up of 6⅝" O.D., 8⅝" O.D. and 10¾" O.D. National Seamless. It was transported to the installation site in Alabama by both barge and rail from plants in Ohio and Pennsylvania.

USS National Seamless Pipe is chosen consistently for the most challenging of cross-country pipeline jobs. Engineers know from past successes, like the "Big Inch" and the Straits of Mackinac crossing, that the best line installations are accomplished with National Seamless. Its high strength, complete uniformity, and a flexibility that lets it absorb ground pressures and bending stresses keep it trouble-free, even under the most punishing conditions.

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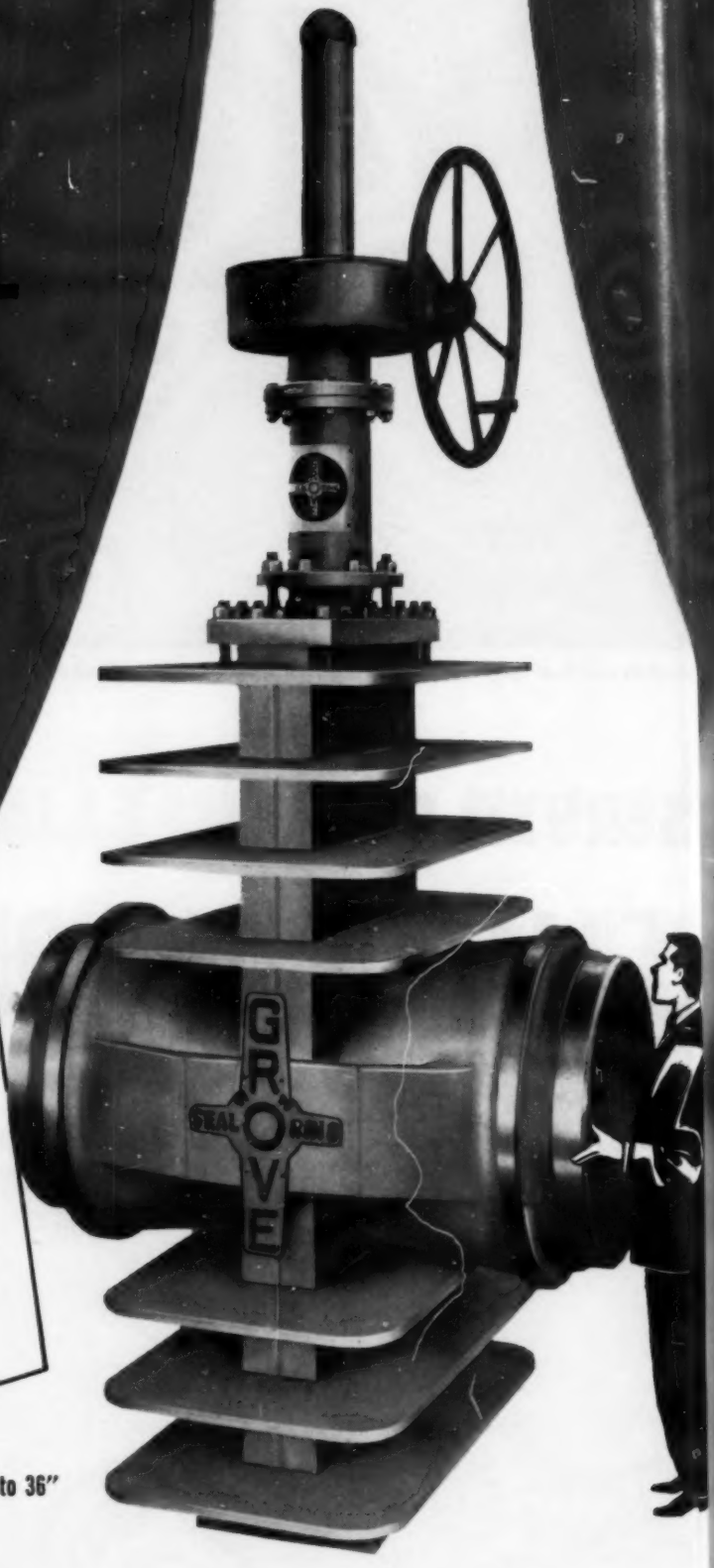

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Laying a 30-in. gas line over a 7,000-ft. mountain in winter temperatures as low as 10° below zero is a job for experienced men and tough machines. R. H. Fulton and Co. had plenty of both when they tackled a 252-mile assignment on the leg between Corona and Gallup, N. Mexico.

Eight Bucyrus-Erie 22-B dragshovels were used for trenching. These machines turned in remarkable endurance records, working on steep and rocky terrain. The total excavation ran about 3½ million yards, most of it blasted malapai, broken limestone and varying sandy soils. Spread Supt. Boyd was particularly pleased with the high percentage of operating time of the 22-B's — 92 per cent.

Other Bucyrus-Erie equipment on this job included a 15-B and 22-B clamshell and a 22-B Transit Crane.

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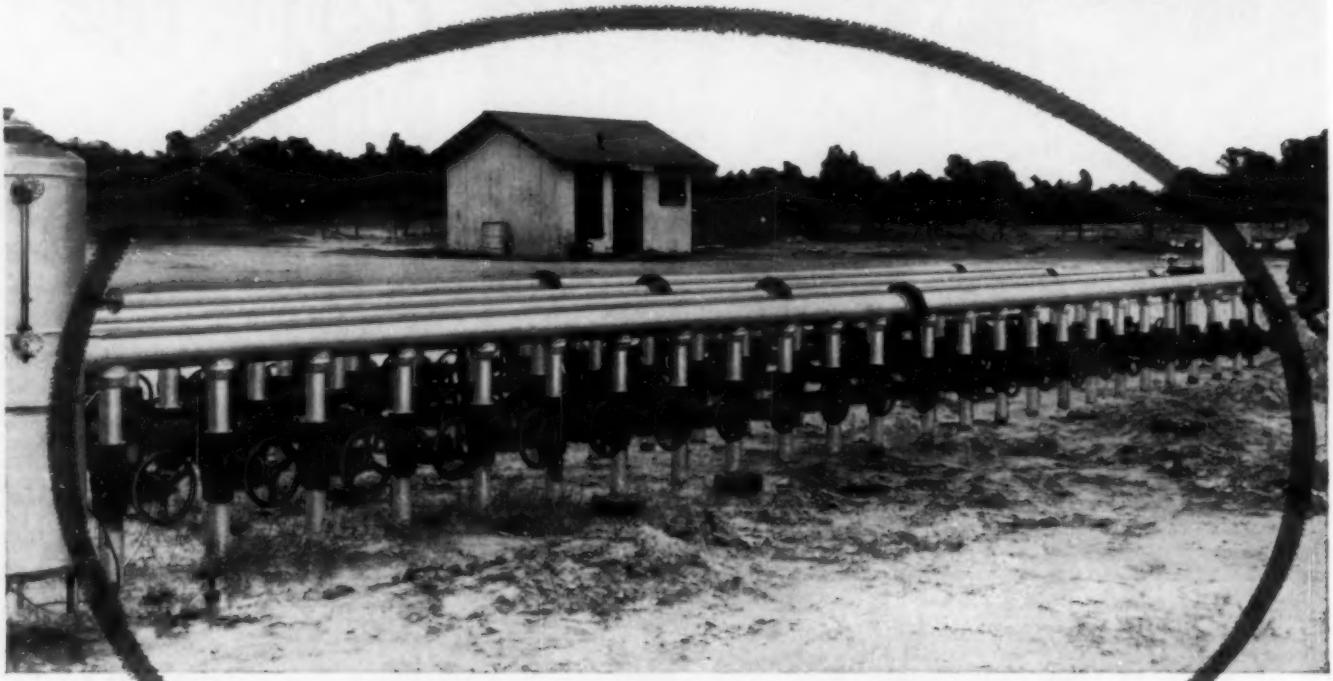

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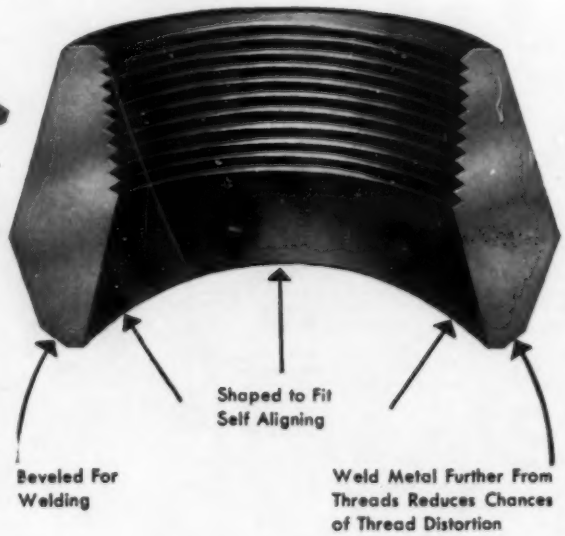

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WHO'S MEETING WHERE

AUG. 29–31	Appalachian Gas Measurement Short Course, West Virginia University, Morgantown.
SEPT. 11–13	Independent Natural Gas Association of America, Jasper Park Lodge, Jasper, Alberta.
12–14	American Institute of Electrical Engineers, Electrical Conference of the Petroleum Industry, Shamrock Hotel, Houston.
12–16	Instrument Society of America, Conference and Exhibit, Los Angeles.
12–16	Corrosion Short Course, Washington University and St. Louis Section, National Association of Corrosion Engineers, St. Louis.
13–24	International Instrument Congress and Exposition, Philadelphia.
14–16	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N.J.
22–23	Mid-Continent Oil & Gas Association, Louisiana-Arkansas Division, Membership Meeting, Roosevelt Hotel, New Orleans.
22-23	Products Pipe Line Control and Dispatching Group, Annual Meeting, Lennox Hotel, St. Louis.
25–28	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Roosevelt Hotel, New Orleans.
27–30	International Gas Union Conference, Hotel New Yorker, New York.
28–29	American Institute of Electrical Engineers, Industrial Electronics Conference, Rackham Memorial Auditorium, Detroit.
OCT. 2– 6	American Society for Testing Materials D-2, Petroleum Products and Lubricants, Statler Hotel, Washington.
3– 7	American Institute of Electrical Engineers, Morrison Hotel, Chicago.
12–14	National Association of Corrosion Engineers, Permian Basin Corrosion Tour, Lincoln Hotel, Odessa, Texas.
17–19	American Gas Association and Pacific Coast Gas Association, Ambassador, Biltmore and Statler Hotels, Los Angeles.
17–21	National Safety Congress, National Safety Council, Chicago.
18–21	National Association of Corrosion Engineers, South Central Regional Meeting, Shamrock Hotel, Houston.
21–23	First Cuban Congress on Petroleum, Sponsored by Universidad de Oriente (University of Oriente), Santiago de Cuba.
24–26	American Standards Association, Annual Meeting, Sheraton Park Hotel, Washington, D.C.
24–27	National Association of Railroad and Utilities Commissioners, Natural Gas Panel Discussion, Asheville, N.C.
27–29	Rocky Mountain Oil & Gas Association, Cosmopolitan Hotel, Denver.
31–Nov. 1	Independent Petroleum Association of America, Jefferson Hotel, St. Louis.
NOV. 2– 4	Society of Automotive Engineers, Diesel Engine Meeting, Chase Hotel, St. Louis.
13–18	American Society of Mechanical Engineers, 75th Anniversary Meeting, Hilton and Blackstone Hotels, Chicago.
14–17	International Automation Exposition, Navy Pier, Chicago.
14–17	American Petroleum Institute, Annual Meeting, Mark Hopkins, Fairmont, St. Francis and Palace Hotels, San Francisco.

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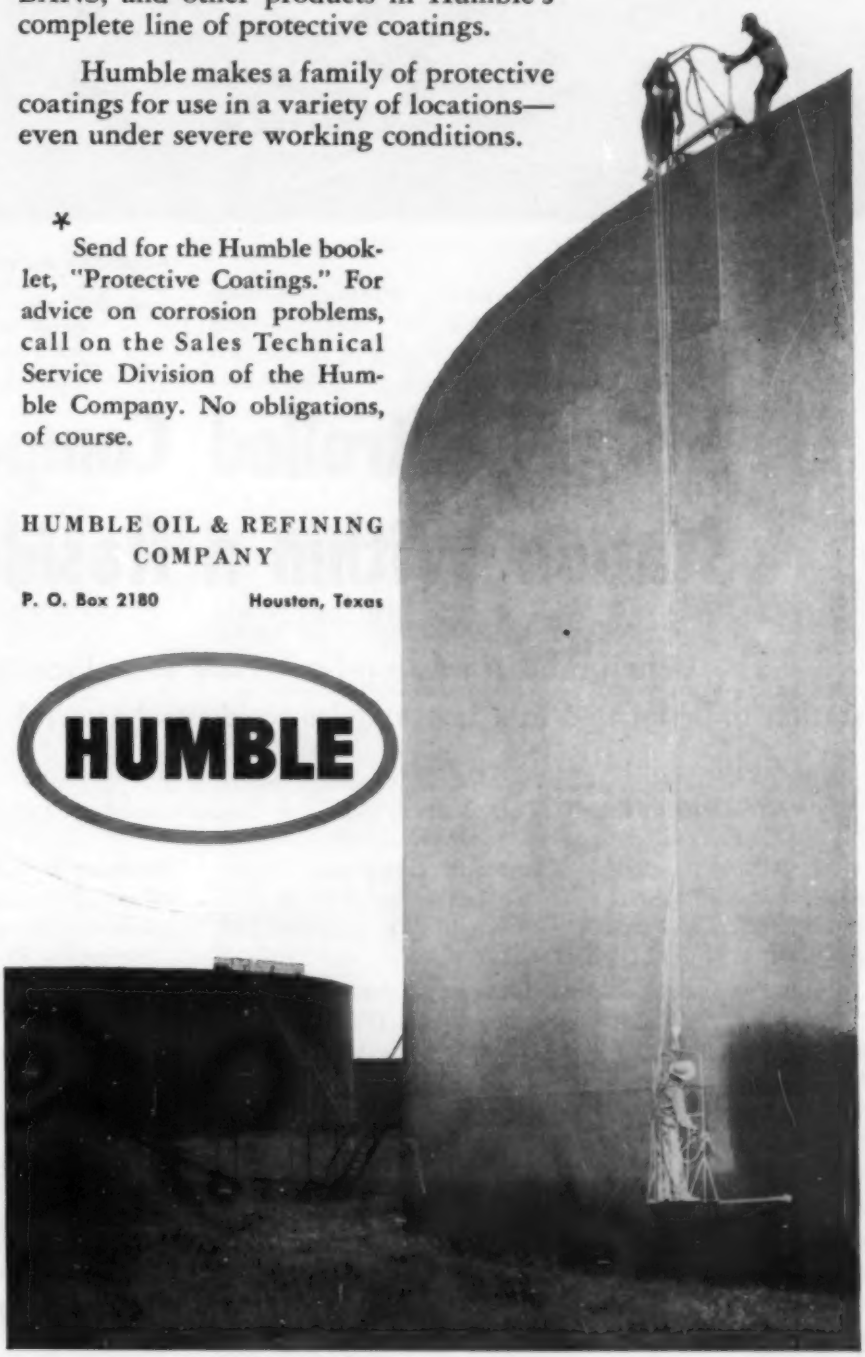

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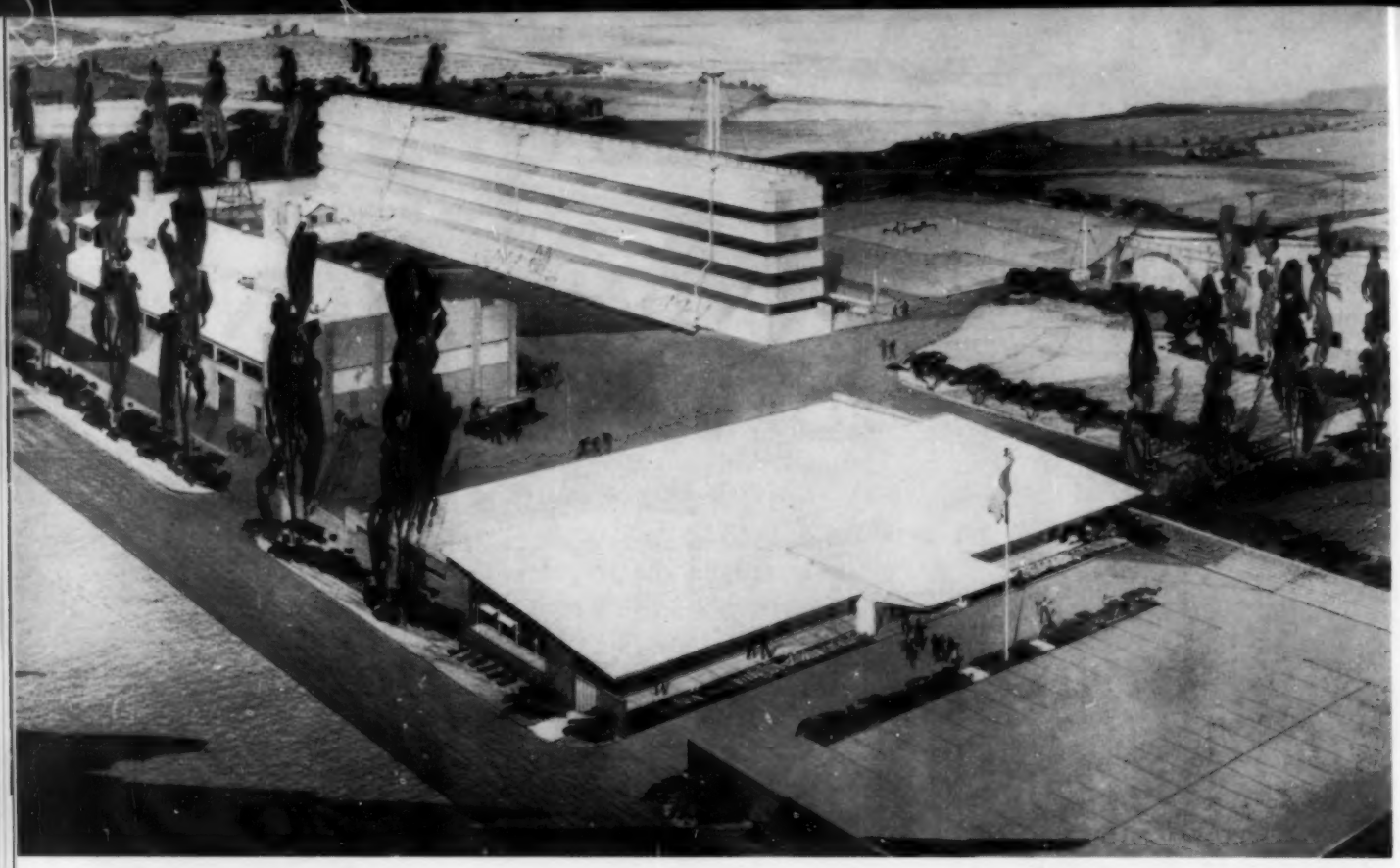

Acoustically designed compressor station to be constructed in a rapidly-growing residential area in the City of Los Angeles for Southern California Gas Company. It has 11,650 hp, is of masonry construction, designed to suppress radiated and engineroom noise.

Noise-Controlled Compressor Station Within a Residential Area

The problem was n-o-i-s-e. How to reduce the noise level in a compressor station to be located in a Los Angeles residential area! Acoustical thinking went to work.

By RAYMOND C. BAIRD, Consultant to the Fluor Corporation, Ltd., Los Angeles

MANY NEW IDEAS on how to reduce compressor station noises are being incorporated into the design of a new station to be constructed within the city limits of Los Angeles.

Southern California Gas Company faced the ever-present noise problem when they began plans to build a compressor station within a heavily-populated residential area of Los Angeles.

They tackled this with the knowledge that station noise has created many legal problems because of its effect on human hearing property values. In this residential area, it was more important than ever to study the acoustical characteristics of the station with effective noise-control methods as the aim. The big objective was to cut down on the noise radiating from the plant toward surrounding areas.

Sources of noise. The most important noise sources are of course the compressor engines. Noises generated by the auxiliaries are secondary because of their low intensity.

Referring to Figure 2 it will be noticed that mufflers and intakes are placed in lines parallel to the building wall. If the building is of a sound-barrier type of construction, noise which would otherwise radiate through the building is reflected and serves to increase the noise that radiates directly from mufflers and intakes in a direction away from the building. At a point a short distance from the building the noise level can be 2-3 decibels greater than it would be without such reflection.[1]

If radiated noise is to be kept to a minimum in a definite direction from the plant site, it would obviously be of considerable advantage to locate mufflers and intakes on the opposite side of the building, or at least keep them out of direct line of sight.

The human ear. The aural sensitivity of the average human ear varies with both frequency and intensity as summarized in the well-known Fletcher-Munson curves relating apparent loudness with intensity as a function of frequency.[1] Using these curves, the American Standards Association devised acoustical weighting curves which account for audibility changes, for use in determining the subjective effect of a particular noise on the human ear.[2]

In dealing with noise we are concerned with this audibility effect on the human ear. For this reason, the proper weighting curves should be carefully applied, particularly whenever a legal guarantee of noise level is involved. (Unless otherwise noted all noise levels specified here are in decibels absolute, or the result of "C" weighting measurements).

Sound and Pulsation Waves in exhaust, intake and compressor lines form the primary sources for sound energy radiated from the compressor unit. Figure 3 illustrates such waves as actually recorded for single stage compressors driven by a 4-cylinder, 4-cycle gas engine. In Figures 3 (a), (b), and (c), the wave shape and attenuation (lessening in intensity) can be seen as it propagates through exhaust and intake lines. Notice high degree of muffler attenuation, particularly for high frequency components. In Figure 3 (d) suction and discharge pulsation in the compressor bottles is shown. Although this pulsation cannot propagate directly to the atmosphere, it can and often does produce undesirable engine room noise.

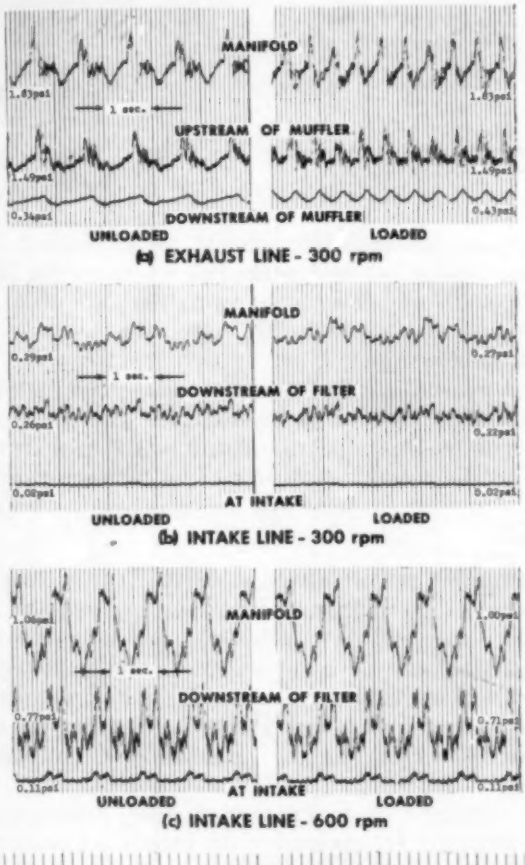

FIGURE 3—Typical pulsation waves.

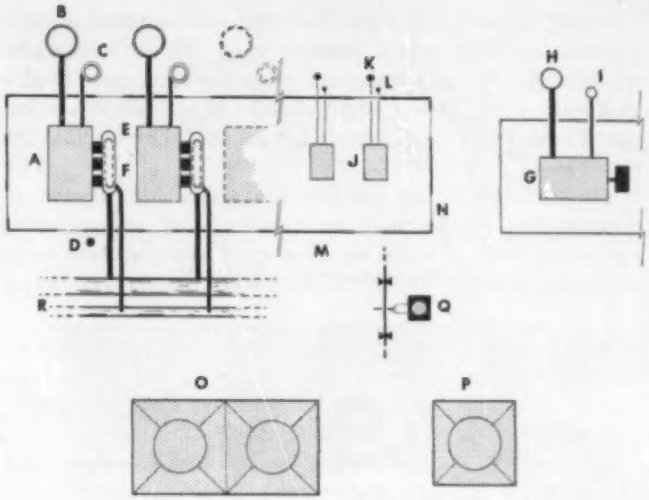

FIGURE 2—Sources of compressor station noise: A—Compressor engine, B—Engine's exhaust line and muffler, C—Engine's intake line and filter, D—Compressor blow-down, E—Suction, volume bottle, F—Discharge, volume bottle, G—Gas engine driven generator, H—Generator's exhaust muffler, I—Generator's intake filter, J—Auxiliaries, engine driven pump, K—Pump's exhaust muffler, L—Pump's intake, M—Compressor building (secondary source), N—Building's ventilation intakes, O—Cooling tower, P—Atmospheric heat exchanger, Q—Gas metering, R—Yard piping.

Beat-frequency phenomenon. A hard-to-control acoustical effect comes from non-synchronized compressor engines. It is the beating together of noise components closely related to each other in both frequency and amplitude. This phenomenon gives rise to additional noise components similar to the creation of side-bands in radio parlance. The lack of synchronization between the compressor units in a typical engine room causes the beat frequencies to often vary widely and provides a major stumbling block to accurate noise evaluation.

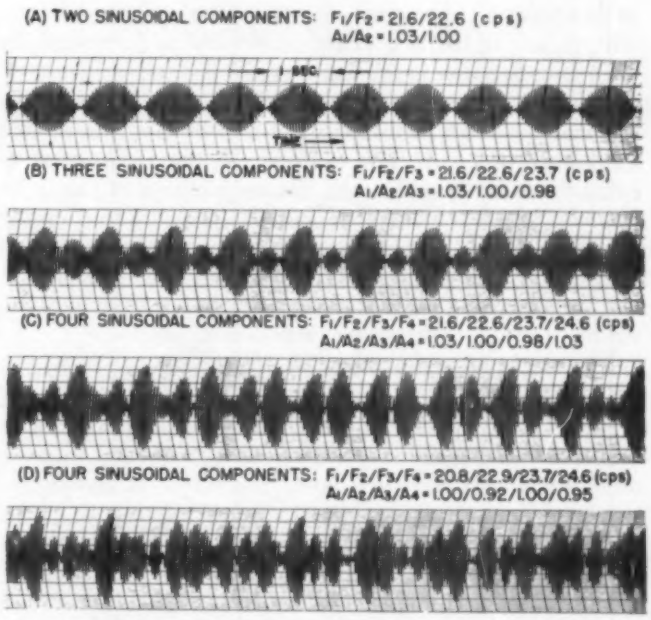
(A) TWO SINUSOIDAL COMPONENTS: F1/F2 = 21.6/22.6 (cps)
A1/A2 = 1.03/1.00
1 SEC.
TIME
(B) THREE SINUSOIDAL COMPONENTS: F1/F2/F3 = 21.6/22.6/23.7 (cps)
A1/A2/A3 = 1.03/1.00/0.98
(C) FOUR SINUSOIDAL COMPONENTS: F1/F2/F3/F4 = 21.6/22.6/23.7/24.6 (cps)
A1/A2/A3/A4 = 1.03/1.00/0.98/1.03
(D) FOUR SINUSOIDAL COMPONENTS: F1/F2/F3/F4 = 20.8/22.9/23.7/24.6 (cps)
A1/A2/A3/A4 = 1.00/0.92/1.00/0.95

FIGURE 4—Generation of beat-frequency noise components.

Figure 4 illustrates the beat-frequency effect for com-

binations of two, three, and four non-synchronized sinusoidal sources.[3] The actual frequency (F_1/F_2 etc.) and amplitude (A_1/A_2 etc.) ratios are given for each case. Notice in Figure 4 (d) how a slight change in the ratios as compared with Figure 4 (c) results in greatly altered pulsation waveform.

The beating effect for low frequency components of exhaust and intake noise in a large plant can produce variations in total noise of more than ten deceibels or so at nearby points. This aperiodic variation can be a major

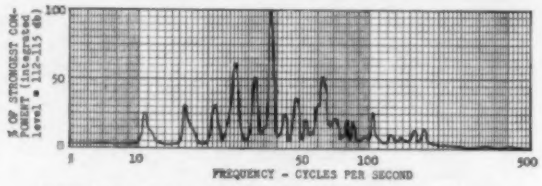

FIGURE 5—Exhaust and/or intake noise components.

source of annoyance in residential areas, even though the actual noise levels be extremely low. Another result is the generation of noise components of varying frequencies. From time to time such components may have frequencies sympathetic to the natural frequencies of residences, and produce vibration and secondary noise which can become a primary source of annoyance to a home owner.

Frequency distribution—Exhaust and intake noise. Figure 5 shows the spectral distribution of exhaust noise measured in a large pipe line compressor plant 25 feet away from the muffler line. (Some of the components present are the result of intake noise.) In this particular case, the over-all sound level varied as much as three decibels because of the beating effect previously discussed.

The frequency-component type of noise analysis provides much information lacking in the speedy octave type analysis which is described later.[1] Its chief advantages lie in pin-pointing the source of offensive noise constituents, with regard to frequency, and in helping to determine the most effective way to minimize them.

Acoustical resonance. It is safe to say that the phenomenon of resonance lies at the root of most noise (and vibration) problems. For example, in the attenuation of exhaust or intake noise, the silencing equipment may be resonant to particular frequencies to the extent that should such frequencies exist in the noise, the equipment becomes acoustically transparent and provides no attenuation whatsoever. As a matter of fact, resonance may actually act to "amplify" certain frequency components.

The resonance phenomenon illustrated in Figure 6 shows a rigid-walled enclosure containing a sound source S. At certain frequencies, standing waves as shown can be set up depending upon sound velocity, frequency, and the dimensions a, b, and c. (Note: the waves as shown are waves of acoustical current which are 90° out of phase with their associated pressure waves.) If the dimension a is made long relative to b, and c, and the area bc is made circular, we have an exhaust or intake line with a full standing wave oriented along its axis. Under this condition, the line is transparent to the transmission of waves having that frequency.

Acoustical discontinuities. Acoustical resonance requires the presence of acoustical discontinuities in the acoustical flow path. Therefore, to suppress standing

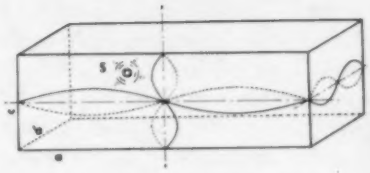

FIGURE 6 — Standing waves in resonant chamber.

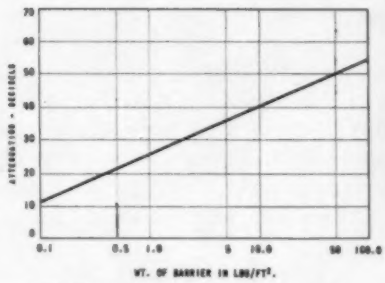

FIGURE 8—Sound barrier attenuation.

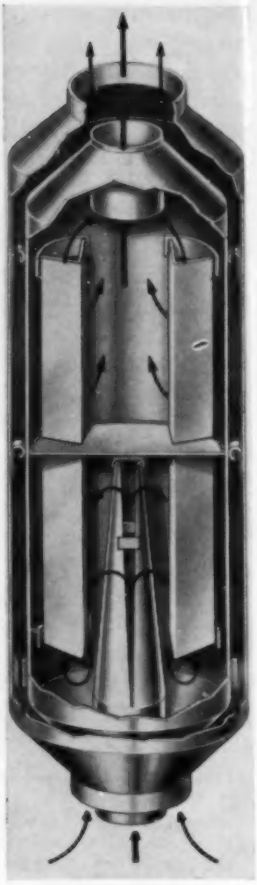

FIGURE 7—Diffuser at muffler inlet.

waves, such discontinuities should be eliminated. With reference to exhaust and intake line resonance the abrupt change in cross-sectional areas at muffler and intake filter junctions should be minimized. A practical way to do this is illustrated in Figure 7.

With the diffuser shown it is extremely difficult to set up a standing wave in the exhaust line. The use of a diffuser is not necessary if exhaust and intake lines are carefully cut to non-resonant lengths. A non-resonant line allows a muffler to perform as the manufacturer intended it should.

Containment of engineroom noise. It is obvious that suppressing the radiation of engineroom noise away from the plant area will be of benefit to the residential noise picture. This can be done by using a tightly-bonded building made of materials which, because of high density, are relatively opaque to sound. Figure 8 illustrates the effect of material weight on the attenuation of transmitted sound.

The containment of engineroom noise, however, gives rise to the need for preventing the increase of room noise level and reverberation time which will ensue. For this purpose, sound absorbing materials can be installed within the building to give very satisfactory results for a nominal expense. However, it should be remembered that a given amount of absorbing material can be used in many different ways to give varied results, all depending upon the "texture" or frequency composition of the engineroom noise, and to some extent upon building geometry.[4]

Placement of engine air intakes. The nature of the

acaustical energy produced at the compressor engine intake has not been well recognized. Like exhaust noise, intake noise also contains frequency components to which the ear is quite sensitive. However, this audible intake noise may be accompanied by an intense, excedingly low frequency pulsation wave which lies below the limit of sound audibility for the average human ear. In many cases this sub-audible wave contributes the largest amount of energy to the intake total. Furthermore, standard sound measuring equipment will not measure acoustical energy having frequencies below 15-20 cps. Accordingly, intake sound levels are very likely to be misleading and much on the conservative side.

It is beyond the scope of this article to appraise acoustical filtering techniques applicable to pulsation suppression inasmuch as high-amplitude pulsation waves such as produced by reciprocating compressors, having the nature of ballistic shocks, cannot be simply handled by conventional methods of muffling.[3]

Yet engine intakes can be a serious trouble source in residential noise problems. Field measurements show that these sources can produce sound levels of more than 120 decibels.

To minimize the radiation of intake noise, the intakes should be placed away from the long sides of the buildings so as to reduce the reflecting effect of building walls. Figure 9 shows one way of doing this. The intake filters (D) are placed in small rooms (B) of masonry construction in either end of the compressor building, with intake lines situated in a trench (C). The intake rooms should be deresonated by using non-parallel walls so as to discourage resonance of the type illustrated in Figure 6.

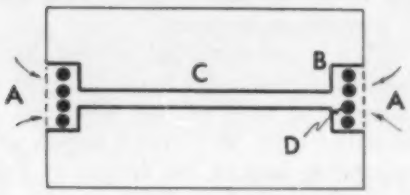

FIGURE 9—Placement of intakes.

Characteristics of engineroom noise. Figure 10 gives some of the results of exhaustive measurements of engineroom noise for different makes and types of 300 rpm gas-engine driven compressor plants. These are in the form of octave analyses, previously mentioned, wherein the total amount of sound energy in a band of frequencies is totallized to give a single value representative of the amount of energy lying within the band. This type of analysis is very useful in handling problems involving the application of sound absorbing materials but, as pointed out, frequently fail to tell the most important aspects of the story.

Curves "R" are representative of installations with gas engines having reciprocating scavengers. Measurements

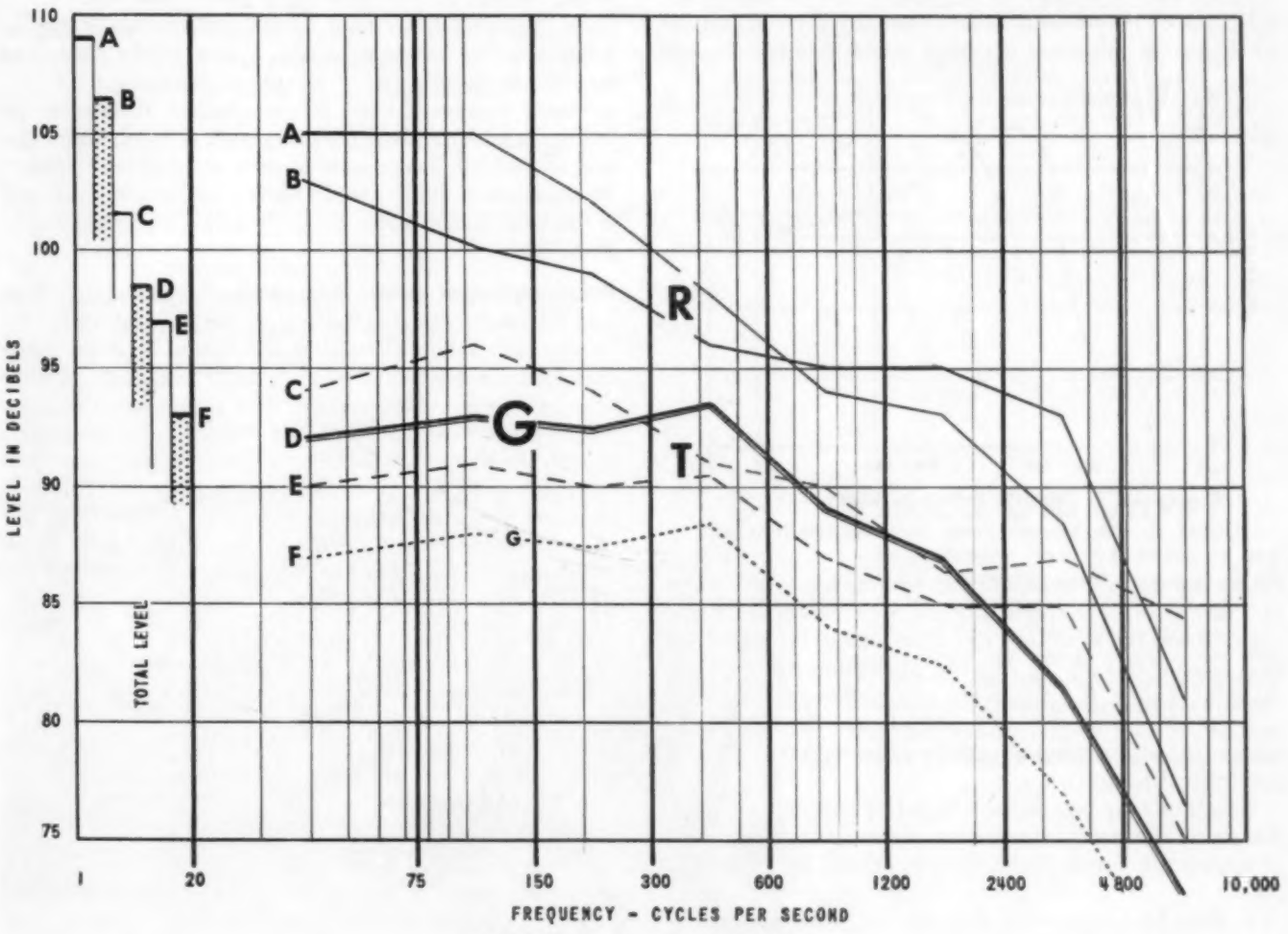

FIGURE 10—Engineroom noise analyses.

have shown that a considerable portion of the noise energy in the lower frequency bands, feeds back exhaust and intake noise into the engineroom.

Curves "T" are representative of installations using engines of exhaust-driven turbocharged variety. Notice the relative reduction in level in the lowermost frequency bands as compared with "R". This is largely attributable to the corresponding lack of low frequency exhaust and intake noise which usually feeds back into the engineroom in the average plant.

Curve "G" is representative of engineroom noise arising from gear-driven turbocharged gas engines with compressors, corrected for estimated feedback of exhaust and intake noise. It represents the noise spectrum which would be present in a sound-barrier type compressor room with a small amount of noise absorption from the use of sound absorbing panels. This curve is based upon a number of field measurements at different installations.

Curve "G" is a predicted noise curve for a single gear-driven turbocharged gas engine at a distance of 5-10 feet if there are no reflecting surfaces in the vicinity of the unit. In other words, it is thought to be representative of the noise spectrum which would be present if one of these units, with compressors, were operated in an anechoic chamber (if such a thing were possible!). This hypothetical analysis represents a situation with maximum application of sound absorbing materials in a room containing a single operating unit.

Acoustical absorbing material. Acoustical absorbing material can be applied at reasonable cost to reduce the build up of reverberent noise in an engineroom. Figure 11, Curve A, illustrates a typical sound absorption curve

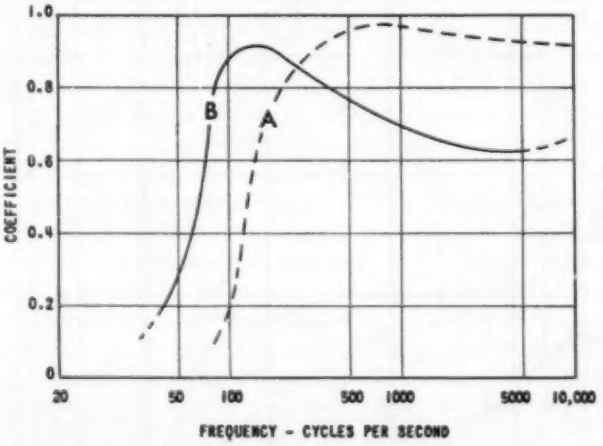

FIGURE 11—Change of absorption coefficient with frequency.

for a commercially available high-quality material. Notice also in Figure 10 that much of the noise energy in typical engineerooms lies at the low frequency end of the spectrum. It is possible to shift the effective absorption curve for the material, Curve B, to provide more efficiency at lower frequencies (with some loss at the higher) by resorting to the use of various types of perforated facing materials and geometrical forms.

How this may best be accomplished will depend upon the sound-frequency distribution present, the availability of appropriate forms of absorbing materials, and of course, cost.

It must be remembered that the use of absorbing materials as described will not affect directly-radiated noise and serves to prevent the build up of average engineroom noise level by reducing reverberation. Some work has been done in covering engines with sound barriers, with results which have left much to be desired due largely to increased operating difficulties.

Acoustical treatment. Figure 12 illustrates a practical

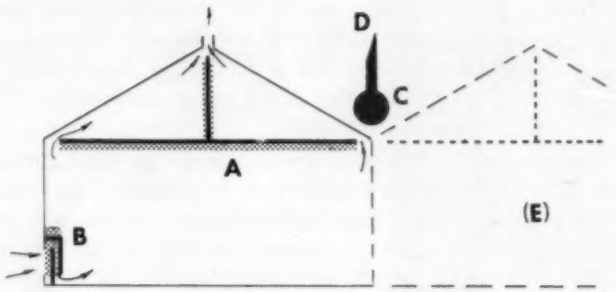

FIGURE 12—Acoustical treatment.

acoustical arrangement for a compressor room. The roof is double-ridged in order to provide defilade for mufflers and tail pipes (C and D) and cause a large amount of exhaust noise to be radiated directly upwards.

Engine room noise is controlled by the use of absorptive materials in the form of a horizontal ceiling (A) plus a vertical section extending upwards to the ridge of the roof. Ventilating air intakes (B) have to be made opaque to sound transmission by using lined ducts whether engine room ventilation is by gravity or forced flow.

An appreciable amount of engineroom noise can be attenuated by wrapping exhaust and intake lines, and compressor bottles, with acoustical blankets. It is important, however, that the wrappings themselves be covered with a protective septum such as sheet aluminum, and acoustically sealed so as to prevent acoustical leakage. In many cases, muffler shells radiate noticeable noise, and it has been found useful to apply acoustical wrapping to them also.

Propagation of noise. It should be recognized that these are extremely variable factors which depend upon the locality and synoptic weather conditions. The likelihood that station noise will cause annoyance in residential areas may be quite indeterminate, and conditions can arise where plant noise can be heard for long distances, even though the source intensity has a relatively low value. The most practical way to minimize residential disturbance is obviously to reduce source noise insofar as practicable and "focus" that which remains in a direction away from residential areas, observing the line-of-sight rule for the location of plant noise sources.

Figure 13 illustrates the major effects of terrain and weather in atmospheric sound propagation. (a) shows how the presence of a hill or other obstacles (large buildings, cooling towers, etc.), prevents sound energy from reaching certain areas, particularly the high frequency components. Low frequency components can, and do, bend around such obstacles as indicated by the dashed propagation path.

Figure 13 (b) illustrates the effect of a temperature inversion in causing sound energy to remain close to the ground in a propagation duct because of a temperature inversion, bending much of the energy which would other-

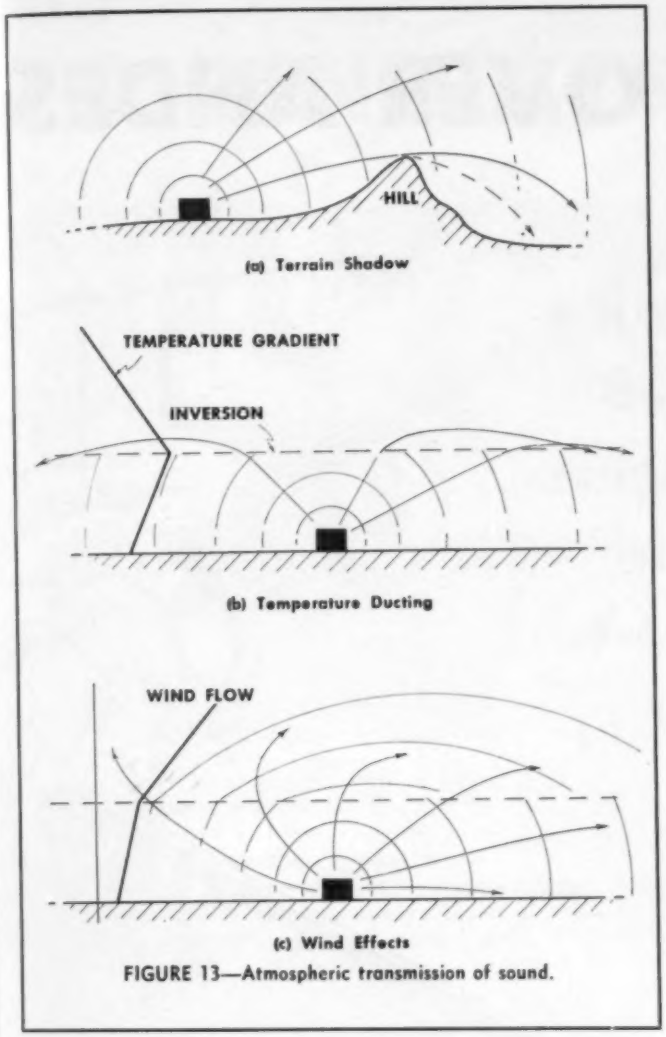

FIGURE 13—Atmospheric transmission of sound.

wise be lost upwards back towards the surface of the ground.

In Figure 13 (c) the bending of sound away from the earth towards the wind is shown. Downwind the energy is brought down to the ground surface. The effect of wind is usually much greater than that of temperature in controlling propagation path.

It is rather obvious that the analysis of the atmospheric propagation picture for a given locality with a view towards determining the probabilities of residential annoyance becomes a complicated procedure when the effects of terrain, temperature, and wind mix together in continually varying proportions.

Acoustically-designed compressor plant. The acoustical thinking briefly outlined here was the result of a definite need to incorporate basic acoustical principles in the design of a compressor station to be installed in a rapidly-growing residential area in the City of Los Angeles by the Southern California Gas Company. Engineering of the plant, designed for high-pressure underground gas storage, is being done by The Fluor Corporation, Ltd. The plant will ultimately have a capacity of 11,650 hp.

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ACKNOWLEDGMENT

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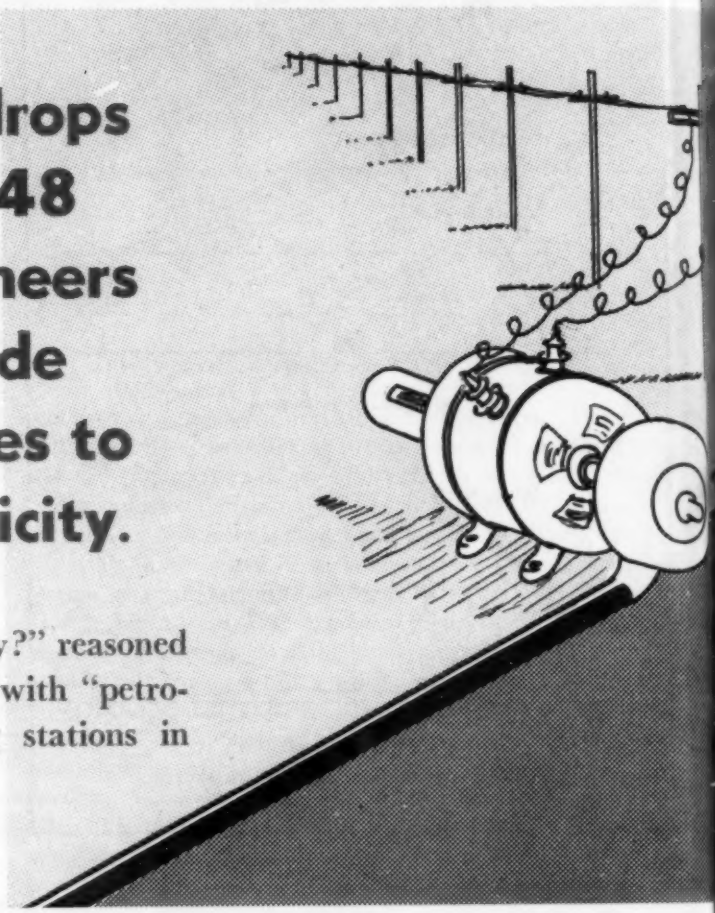
—The End

Good Old Days?

Many a pipeliner has huddled on the flat, hard bed of a truck like this to keep warm on the trip to work. Today, crews ride in comfort in enclosed trucks—with heaters in the front and rear. About 1922, trucks changed from solid rubber to pneumatic tires which made them more versatile, that is, they could run over soft ground without bogging down to the hub caps. This picture was taken in western Kansas in 1923.

CRUDE FLOW OVER ANDES

Proposed line drops 15,000 feet in 48 miles and engineers will run the crude through turbines to generate electricity.



"Why waste the energy?" reasoned the designers. They came up with "petro-electrical" stations (pumping stations in reverse).

By ANTHONY GIBBON,
PIPE LINE INDUSTRY Staff

BOLIVIAN CRUDE OIL flowing through a pipe line may turn the turbines to generate electricity for industry. If the project is successful it may, under certain conditions, substitute for hydropower where this is not available. It will mark a revolutionary step in the pipe line industry, utilizing the energy inherent in the movement of crude oil or petroleum products flowing through a conduit.

The project was designed by Williams Brothers, pipe line contractors, of Tulsa, Okla., and it has the support of the Bolivian government. Work is expected to begin in about a year.

The project is being engineered by Williams Brothers in connection with a crude oil line under construction from Sica Sica, Bolivia, to Arica, Chile, a port city on the Pacific Ocean.

The line will extend over the Andes mountains and will drop from a height of 15,000 feet to sea level within a distance of 48 miles.

This great drop in the short distance caused John Williams, president of Williams Brothers, to ask himself "With all that energy, why waste it?" He then thought of the idea of generating electricity by using the crude oil to run turbines. He coined the name "petroelectrical" for the idea and the project will be called a petroelectric plant if and when installed.

Uneconomical at first. Williams Brothers has made an intensive study of the possibility of generating electricity from the flow of crude oil in the pipe line they will build. C. M. Collins, chief engineer for the company, stated the study indicated the project would not be economical when the pipe line is first placed in operation because the volume of crude oil being transported would be only 7000 barrels a day.

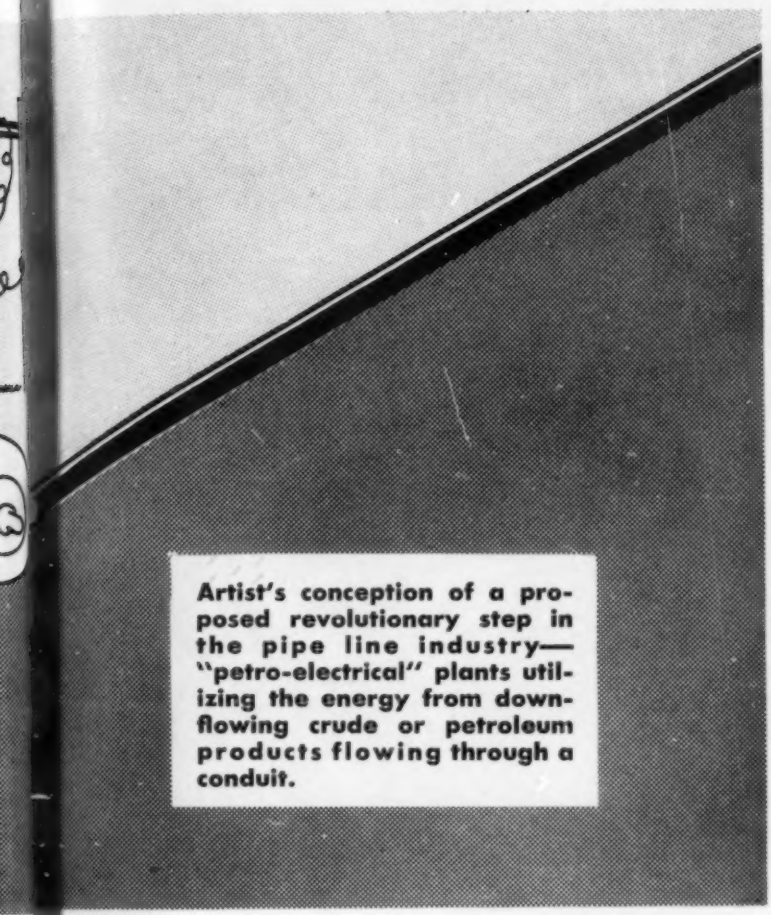
But with the intensive oil well drilling program being started in Bolivia, production of crude oil may be increased substantially during this year to justify the installation.

"When crude oil production to be transported through the pipe line reaches 25,000 barrels a day, and it may reach that figure within a year, generating electricity through flow of the oil through turbines may be economical," Collins said.

Williams is optimistic about the matter and has discussed the proposed project with engineers of electrical manufacturers, whom, he said, are interested.

Williams Brothers has the contract and has started construction of a 6-inch refined oil products pipe line from the Bolivian refinery at Cochabamba to Oruro and thence to the capital, La Paz, a distance of 220 miles. This line will start at an eleva-

TO GENERATE POWER!



Artist's conception of a proposed revolutionary step in the pipe line industry—"petro-electrical" plants utilizing the energy from down-flowing crude or petroleum products flowing through a conduit.

The dots show the 210-mile 10-inch crude pipe line to be constructed by Williams Brothers for the Bolivian oil industry. The line includes the 48-mile drop of 8-inch pipe which is proposed to generate power.

tion of 8,300 feet and reach an elevation of 13,500 feet.

From this line at Sica Sica, Williams Brothers will construct a 10-inch crude oil pipe line to the Chilean port city of Arica, a distance of 210 miles.

On a 48-mile part of this line, which will be of 8-inch pipe, pressure reducing stations will be installed, otherwise a pressure of 4000 pounds per square inch would be built up at the sea level end of the line. These stations also will keep the line filled evenly.

This line will have an initial capacity of 50,000 barrels because Bolivia expects its oil program to develop that much production within the near future.

Construction of this line, to start within a year, will provide Bolivia with an international market for crude oil. It now is exporting 3000 barrels of crude oil daily to Argentina. With 7000 barrels a day initially expected to go through the new line to Arica, Bolivia will be exporting 10,000 barrels a day. Dollars received from this exported oil will place the government on good financial footing.

Bolivia, which expended $9 million a year for its oil requirements, became self-sufficient in oil matters in 1954 and now is saving that $9 million a year. Its potential crude oil production is 12,000 barrels a day and its own requirements are 5000 barrels.

Glenn McCarthy of Houston has a concession of 900,000 acres in Bolivia and his second well is producing 300 barrels a day. McCarthy is shipping a heavier drilling rig to Bolivia to further develop his concession.

Williams Brothers has constructed 560 miles of pipe line in Bolivia, being the only firm to do that kind of work in the country.

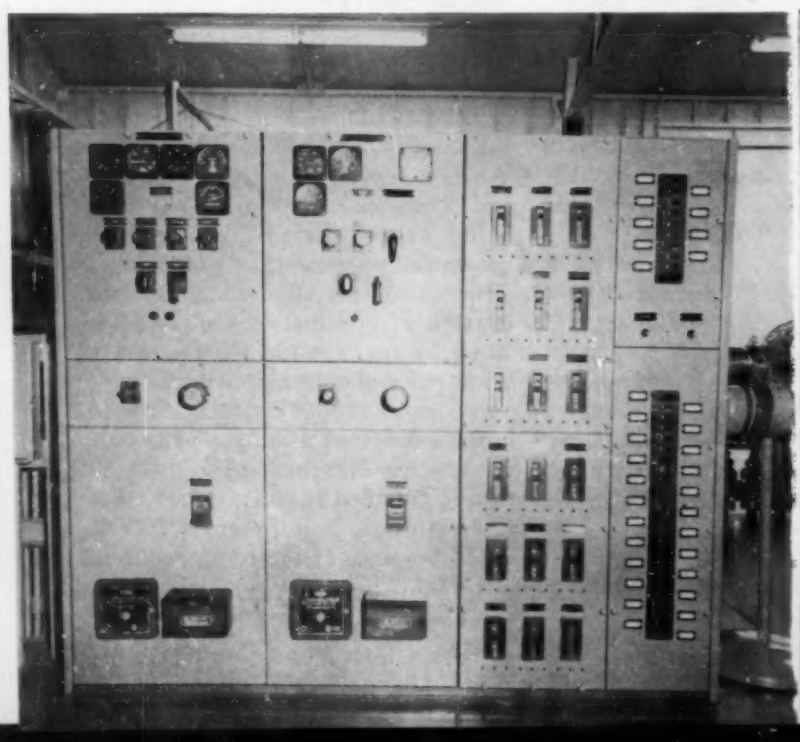
The Bolivian oil industry is operated by a company called Y.P.F.B. The country is open to private enterprise and foreign capital and American companies are welcome to aid in the development of the country.

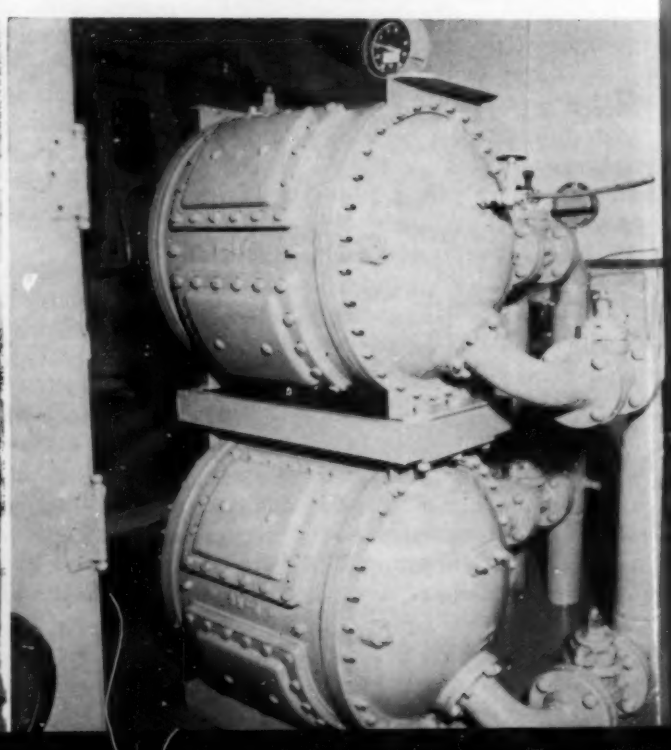
When Williams Brothers completes the crude oil pipe line to Arica, crude for initial operation of the line will be batched through the products line Williams now is building to La Paz. When crude oil production increases sufficiently, the government will have built a 12-inch crude oil line to supply the crude line to Arica.

In using the flow of crude oil through a pipe line to turn turbines and generate electricity, Collins stated it was planned to install hydraulic governors which would correlate the volume of the flow of crude oil through the turbines with the load on the generator. Installed initially would be a 75-kw turbine and future additions would be made as the oil throughput increased. —The End

O-P's Man a Pipe Line . . .

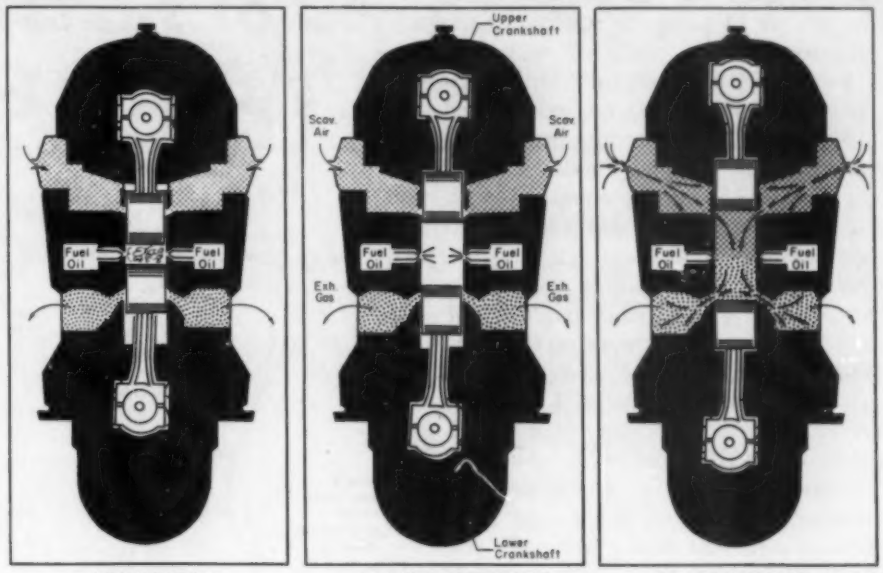
This engine which has two opposed-pistons in every power cylinder, making it the lightest engine for its size in the industrial field, has proved to be a successful pipeliner in 56 months of operation on Southeastern Pipe Line Company's system. Above are two 1600-horse-power engines at Wewahitchka, Florida pump station. Their lifetime operation has been .37 pounds of diesel fuel per hp-hour. Lower left shows the control panel at a typical station which is operated by one man per tour. Lower right, high detergent lube oil is circulated through strut-tube heat exchanger by lube oil circulating pumps; fresh jacket water is coolant.





Pioneering The Opposed Piston Diesel in Pipelining

. . . 56 months of operation on the Southeastern Pipe Line Company system.



Two crankshafts—one top and the other bottom—and two pistons working in opposition in each power cylinder, make the opposed-piston, two-cycle diesel perhaps the most compact engine in the industrial field.

THE SAME DIESEL that long has powered tankers and towboats in moving vast quantities of petroleum products over water is now moving them over land. One of the first companies to use opposed-piston diesels in pipe line service is Southeastern Pipe Line Company of Atlanta, Ga. This is the first report on that company's experience with opposed-piston diesel engines. (O-P's have a long service record in other stationary and pumping applications.) The report shows that the stations concerned were pumping more than 97 percent of the time in the 56 months since installation of the diesels. In all that period, the new engines supplied power at an average fuel consumption of only .37 pound per horsepower hour.

To meet a booming demand for petroleum products, Southeastern Pipe Line Company expanded its 483-mile system between Florida's Gulf Coast and Chattanooga, Tenn. The company has constructed three pumping stations in Florida and Georgia, each powered with two 1600-hp opposed-piston diesel engines, and has increased the capacity of two existing motor-powered stations by 300 hp each. The system's average daily throughput has been increased from an average of 28,000 barrels to 38,200 barrels, with peaks reaching 41,728 barrels per day.

One-man operation. The three newest diesel pumping stations are located at Wewahitchka, Fla., River Junction, Fla., and Newton, Ga. They

Continued on next page

How Opposed-Piston Diesels Work

Fuel for all diesel engines is sent through the main line and is drawn off at each of the three O-P powered stations into a 5000-barrel storage tank. It is then sent through, or bypassed around, a fuel oil centrifuge to a single 2200-gallon day tank by a 50-gpm. rotary pump, driven through 4.15 to 1 reduction gears by a 2-hp, 1715 rpm motor. From this day tank the fuel flows by gravity to each engine, passing through a duplex filter before reaching the engine-driven supply pump on each O-P.

A high detergent lube oil is stored at each of the new stations in a 2200-gallon tank and is transferred to the crankcase of each O-P by means of a 50-gpm motor-driven pump similar to the fuel oil transfer pump just described. It is circulated under pressure through each O-P by an engine-driven pump, passing from the engine through a strut-tube type cooler, through a full-flow strainer, and then back to the crankcase. A bypass line from the pressure side of the engine-driven circulating pump carries a continuous flow of lube through a separately mounted cartridge-type filter for added protection. Lube oil periodically drained from each crankcase is stored in a 570-gallon storage tank before being run through a centrifuge by the 50-gpm transfer pump. It is then sent to a 570-gallon clean oil storage tank.

Soft, fresh water, to which a rust inhibitor is added, is drawn from a deep well at each station and is circulated through the cylinder jackets on each O-P and to the pistons for cooling by means of an engine-driven pump. It passes from the engine to the strut-tube lube oil cooler where it acts as a coolant, and then to a forced draft evaporative cooler located at the rear of the station. A small bypass from the pressure-side of the circulating pump sends a continuous flow of jacket water to the lube oil coolers installed on each speed-increasing gear.

Starting air for each O-P is supplied at a pressure of 250 pounds by a two-stage, 4¼ x 1¾ x 3 air compressor, driven by a 7½ hp, 1750-rpm motor. Compressed air for this and other purposes is stored in four storage bottles.

Scavenging air for each O-P is drawn from the outside through an oil-bath type filter. It is sent to each cylinder by a positive-displacement blower, driven off the upper crankshaft. Exhaust gases are expelled through vertical snubbers, one mounted at the front and one at the rear of the building.

are designed for one-man operation, as are all 14 pumping stations in the system. Each is equipped with two 10-cylinder, 8⅛-inch by 10-inch, opposed-piston diesel engines, rated 1600 hp at 720 revolutions per minute and driving 6-stage, flooded-suction, centrifugal pumps, equipped with 11⅜-inch impellers and rated 1310 gallons per minute at a discharge pressure of 1200 pounds per square inch gage. The driving arrangement for each pump includes a through-bulkhead shaft, flexible coupling, and a speed-increasing gear of 1 to 6.583 ratio which steps engine speed of 575 rpm up to 3785 rpm at the pump.

The two 1600-hp O-P's at each station are operated alternately, each having sufficient power to handle the station's average flow of 1650 barrels per hour. This arrangement provides each station with 100 percent standby capacity under normal conditions. Average suction pressure is 100 pounds and average discharge pressure is 1150 pounds.

The three stations went into operation on January 1, 1950, and since that time have been pumping products on a 24-hour basis. In their first 56 months of service they were actually pumping products 39,286 hours, 39,367 hours, and 40,430 hours respectively, out of a possible total of 40,896 hours, handling a volume of 63,719,187 barrels of products. Despite the fact that they are operated at an average load of from 800 to 850 hp, the average fuel consumption of the six O-P diesels throughout this period was an estimated .37 pound of fuel per horsepower-hour.

Company history. Southeastern Pipe Line Company was organized in October, 1939, with construction of the pipe line getting under way the following January. The system's original design was based on an average throughput of 18,000 barrels per day, handled by a total of five pumping stations. World War II was in progress, however, and at the government's request the partially-completed system was extended to include 11 pumping stations with an average daily throughput of 28,000 barrels. Thus expanded, the pipe line was completed on December 19, 1941. It became the first pipe line to begin operations in the southeastern section of the country.

The SPL system originates on the Gulf Coast at Port St. Joe, Fla., extending northward into Georgia and Tennessee and terminating on the Tennessee river at a point just below Chattanooga. It is supplied entirely by water-borne shipments, the sheltered harbor in St. Joseph's Bay being deep enough to accommodate tankers of the T-2 class as well as barge trains arriving from Texas via the Intracoastal Canal.

Map showing location of the Southeastern Pipe Line Company.

As expanded in 1949, the system includes 14 pumping stations located at intervals of from 23 to 56 miles. The combined available horsepower of these 14 stations is 17,300, of which 12,300 hp is supplied by diesels and 5000 hp by electric motors.

In order to facilitate one-man operation of each pumping station, automatic controls and safety devices have been included wherever possible. All pumps are protected against low inlet and high outlet pressures, hot pump casings, excessive pump bearing temperatures and low or excessive flow. All electric motors are protected against excessive bearing temperatures and all diesel engines are protected against low lube oil pressure and high jacket water temperature.

Between January 1, 1954, and September 1, 1954, the two opposed-piston diesel engines at the Newton, Ga., station were in operation for 4779 hours out of a possible total of 5832 hours. Their average load during this period was 800 hp, representing a total of 3,893,070 hp hours. A 50-kw. diesel-generator set, meanwhile, was in operation for 4882 hours at an average load of 35 hp, representing 169,870 hp hours. Total fuel consumption for these three engines for the eight-month period was 204,360 gallons. At an average weight of 7.2 pounds per gallon, this represents an average fuel consumption for the entire station of .377 pound per hp hour.

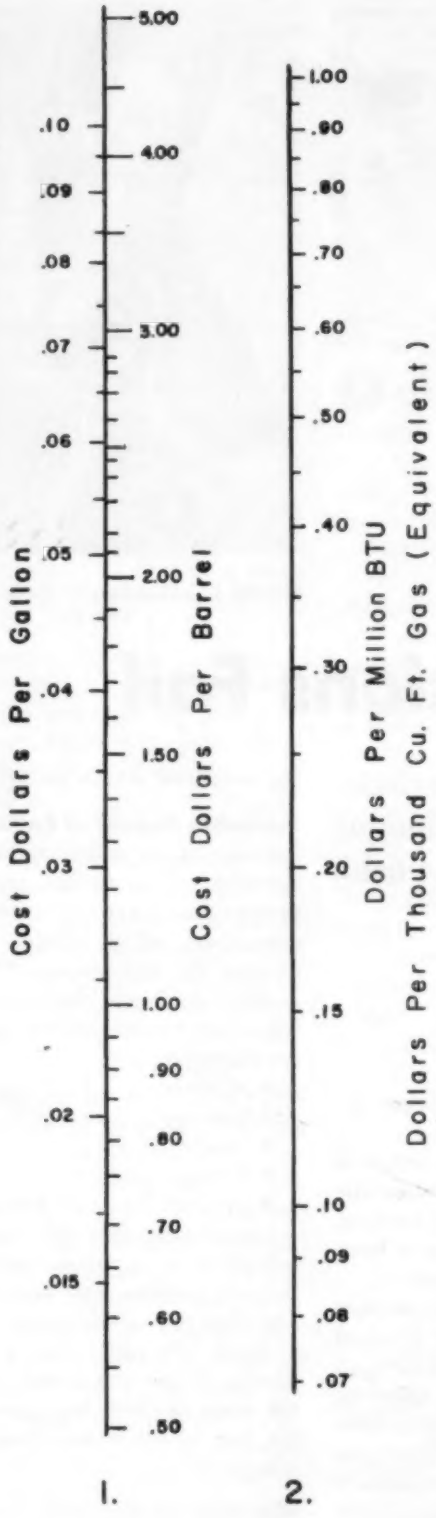
During the same period, the O-P's at the River Junction, Fla., station averaged .369 pound per hp hour; at the Wewahitchka station, the engines averaged .365 pound per hp hour.

The three stations combined were in operation during this period for a total of 12,439,695 hp hours, consuming 640,848 gallons of fuel at an average of .370 pound per hp hour.

LIST OF PRINCIPAL EQUIPMENT
(The following list applies to all three stations)

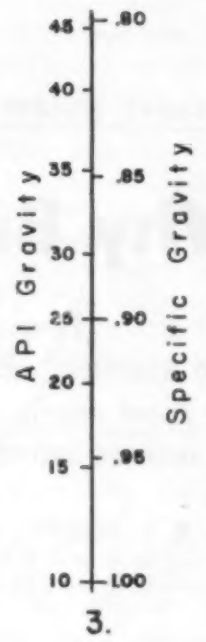
Main Engines	Fairbanks, Morse and Company—Model 38D8-⅛, 10-cylinder, 8⅛x10 opposed-piston diesel engines, rated 1600 hp at 720 rpm.
Main pumps	Worthington Corporation.
Speed-increasing gears	Worthington Corporation.
Governors	Woodward Governor Company.
Duplex fuel oil filters	Commercial Filter Corporation.
Fuel oil centrifuge	Sharples Corporation.
Fuel oil transfer pump	Blackmer Pump Company, Inc.
Lube oil transfer pump	Blackmer Pump Company, Inc.
Lube oil centrifuge	Sharples Corporation.
Lube oil cooler	Harrison Heater Division, General Motors Corporation.
Full-flow lube oil strainer	Purolator Products, Inc.
By-pass lube oil filter	Purolator Products, Inc.
Main Line plug valves	Nordstrom.
Air-intake filters	Continental Air Filter, Inc.
Exhaust Snubbers	Burgess-Manning Corporation.
Gage Panel	Westinghouse Electric Corporation.
Jacket water cooler	Fluor Corporation.
Air Compressor	Worthington Corporation.
Diesel (driving generator)	Cummins Engine Company, Inc.
Generator	Electric Machinery Mfg. Company.
Switchboard	Westinghouse Electric Corporation.
Fire Pump	Hale

Use This Handy Chart to Compare Costs of Gas and Oil Fuels . . .



GAS AND OIL FUELS
COST COMPARISONS
FOR INDUSTRIAL PURPOSES

by Frank E. Hangs
Pipe Line Technologists



USES OF CHART

1. Determine cost / million Btu of oil fuel, given cost per barrel or per gallon and gravity. Lay straight edge from values on scales 1 and 3 read scale 2. Scale 2 values also are equivalent cost MCF of gas (1000 Btu / Cu. Ft.). Obviously, if actual cost of gas is less than equivalent cost then a savings results.

2. Determine equivalent cost / Bbl. or cost / gallon having cost of gas and gravity of oil. Connect values on scales 2 and 3. Read scale 1. Average heating value of oil 19,000 Btu / lb.

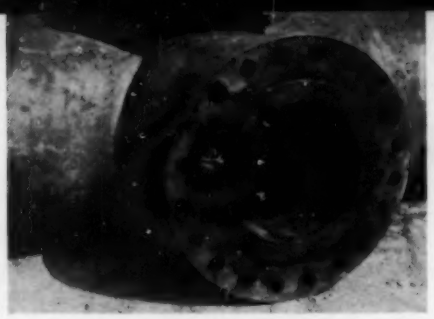


FIGURE 1A—Typical field failure.

FIGURE 1B—Pulsating-pressure test failure.

FIGURE 1C—Failure in cyclic in-plane bending test.

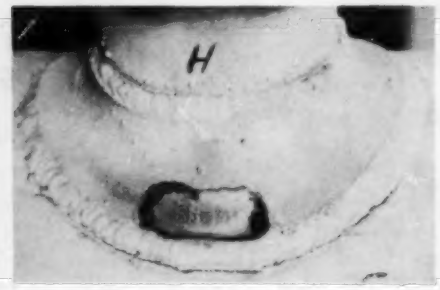


FIGURE 1D—Failure in cyclic transverse bending test.

FIGURE 1E—Failure in hydrostatic pressure test.

FIGURE 1F—Distortion in static pressure and bend test.

Pressure pulsation tests show . . .

Why Branch Connections Fail

How good are ordinary weld saddles, encirclement saddles, tees, and such? Using a testing technique that most nearly duplicates causes of failures in the field, the authors found some surprising results.

By A. R. C. MARKEL, Research Consultant; **H. H. GEORGE,** Manager of Research Department, and **E. C. RODABAUGH,** Senior Research Engineer, Tube-Turns, Louisville, Ky.

FIELD FAILURES IN saddle-reinforced branch connections have led to a re-examination of current design practices. New types of reinforcement have been proposed during this study, notably such as encircling the run or carrier pipe.

To assist the industry in appraising their respective merits, tests were run on six variants of encirclement reinforcement in comparison with unreinforced and saddle-reinforced intersections as defining designs to be improved upon, and with straight unperforated pipe and integral forged welding tees as defining the strength requirements to be met.

Figure 1A is a photograph of a section cut from a pipe line after a field failure of saddle-reinforced branch connections in a large gas transmission line.

Other failures have been reported wherein the saddle, along with the branch pipe, was completely torn off the run pipe. Failures have not been confined to hot-tap connections.

As a result of the failures, serious thought has of late become directed toward improving the design of branch connections and a number of alternate reinforcement details suitable for hot-tapping have been proposed; these are shown in Section 8 of the Code for Pressure Piping, ASA B31.1. To assist pipe line operators in evaluating their respective merits, the author's company two years ago, after extensive preliminary study of the problem, initiated the test program the results of which are given here.

Probable Causes of Failures. In the instance of the saddle reinforced connections whose failure triggered the present investigation, the exact circumstances which produced the field failures are not known. The failures could have been due to any of the following causes, either singly or in combination:

- Material
- Welding
- Design
- Internal pressure effects
- Applied forces or moments

Considering first the materials involved, it is apparent from the fact that the saddles were torn out of the line that the saddle material was not at fault. The pipe material itself likewise must be exonerated since it was the same as used throughout miles of the line where it acquitted itself satisfactorily.

Welding. Weld defects may have provided focal points for crack formation. While the maintenance of good weld quality is an important factor in the assembly of piping, there is some question as to whether defects could

have constituted the primary cause in the average service failure.

From what the authors have been able to learn, saddles almost invariably failed by tearing out along the toe of the attachment weld to the carrier pipe; while shallow notches caused by undercutting might have contributed, their stress raising effect would normally be expected to be overshadowed by that of the sharp change in cross-section and contour associated with the basic geometry of a fillet weld.

The possibility of the formation of underbead cracks deserves consideration in view of the common practice of employing cellulose coated (hydrogen-releasing) rods in welding the high-strength pipe used in transmission lines, with its relatively high carbon and manganese contents; however, to the authors' knowledge, no saddle failure has yet been traced to this cause.

Design. While a saddle does not afford direct support to the branch intersection proper and thus falls short of an ideal reinforcement, its performance record through the years has been generally satisfactory.

To prove that a properly proportioned saddle will provide 100 percent reinforcement for large-diameter pipe under steady-load conditions, a bursting test on a 22-inch x 10-inch connection was incorporated in the present program; failure, of the character shown in Figure 1E, occurred at 2100 psi pressure which is about the same as would be predicted for the 22-inch OD x 5/16-inch wall pipe of 71,000 psi tensile strength used for the run.

It is also known that a saddle provides an excellent means for spreading out the effects of external bending moment introduced through the branch pipe; while simultaneously under an internal pressure stress in excess of 72 percent of the yield strength of the carrier pipe material, the 22-inch x 10-inch assembly shown in Figure 1F withstood a 300,000 foot-pound transverse bending moment (with a corresponding calculated extreme fiber stress of 73,000 psi in the branch pipe at the point of external failure) before the branch pulled away from both the carrier pipe and the saddle; note the large amount of distortion preceding rupture.

Superimposed loadings. It has already been shown that a saddle reinforced connection will not generally fail any sooner than straight pipe under sustained internal pressure, and that it will withstand a single application of a bending moment higher than any which . . e been recorded in pipe lines, while already stressed to the maximum pressure used in transmission line design.

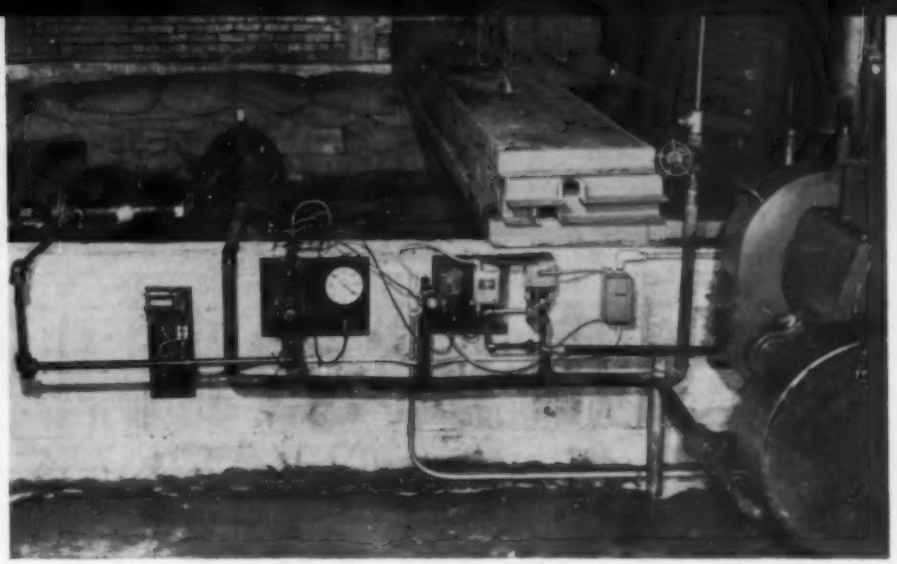


FIGURE 2—Pressure-pulsation test apparatus.

This would also imply that other possible one-time loads, such as ordinary settlement or shifting of the earth, would not by themselves lead to rupture. What then could have caused failure in service? The observation that field failures are not usually experienced until after the line has been in service for a considerable time would lead one to conclude that, in the absence of corrosion or creep effects, failures must be initiated by some form of cyclic loading.

In considering the types of cyclic loading which might be imposed on a branch connection in a transmission line, temperature variations probably can be ruled out as a major contributor. In the bulk of the buried lines, the temperature variations are of a low order and, while productive of relatively high thrusts, their frequency is too low to cause early fatigue; there is only one major cycle per year.

The line pressure varies with the demand for gas, with probably one major fluctuation in flow rate per day. Superimposed on these slow cycles may be pulse pressures possibly attaining the sonic velocity of gas and an amplitude approaching 15 percent of the line pressure.

When pressure fluctuations occur in the line, particularly if resonant conditions are encountered, the branch connections will be subjected to a measure of shock or to vibrations.

To reinforce this opinion and to demonstrate that field failures can be closely duplicated by cyclic tests in the laboratory, the authors have subjected representative saddle reinforced assemblies to pulsating pressure tests and to bending fatigue tests, with moments applied in and transverse to the plane of the intersection.

The failures obtained are illustrated in Figures 1B-D; note the resemblance to the field failure depicted in Figure 1A, differences in the extent of crack propagation being accounted for by differences in the stored energy released at the point of failure, which would be much less in a small water-filled vessel than in a large gas-filled line.

Selection of test method. The pulsating pressure test was adopted for this comparative test series. The mean pressure was set at approximately 72 percent of the actual yield strength of the run pipe material used, this value being used because it conforms to the maximum design stress allowed for cross-country piping. The superimposed cyclic pressure variation was of the order of ± 20 percent of the yield strength.

Tests were run on both full-scale 22-inch x 10-inch connections and models reduced to 58 percent of the full size in every detail, the former using API 5LX-52 pipe for the run, the latter using A106, Grade B pipe. This was done primarily to find out whether underbead cracking was a significant contributor, and also to determine whether results could be extrapolated to geometrically similar assemblies of different size.

Test apparatus and procedure. The test apparatus developed for these

TABLE 1
Significant Data on Three Test Series

Test Series No.	Pressure Range (psi)	CARRIER PIPE SIZE AND MATERIAL			Yield Strength (psi)	Calculated Stresses (psi) Corresponding to Pressure Range		Stress Ratios	
		O.D.	Thickness	Specification	S	S_{min}	S_{max}	S_{min} / S	S_{max} / S
1	650—1300	12¾″	.188″	ASTM A106, Gr. B Seamless	48,600	22,000	44,000	.45	.91
2	900—1500	22″	.312″	API-5LX52 Resistance Welded	57,500	31,700	52,800	.55	.92
3	1000—1650	22″	.312″	API-5LX52 Resistance Welded	60,500	35,200	58,100	.58	.96
		22″	.312″	API-5LX52 Resistance Welded	63,500	35,200	58,100	.55	.92
		22″	.312″	API-5LX52 Flash Welded	63,800	35,200	58,100	.55	.91

TABLE 2
Physical and Chemical Properties of Components of Test Assemblies

Component of Assembly	Test Specimen Numbers	Yield Strength (psi)	Ultimate Strength (psi)	Elongation (Percent)	CHEMICAL COMPOSITION				
					C	Mn	P	S	Si
12¾″ O.D. x .188″ Run Pipe used in Test Series No. 1	B_1, B_2, C_1, C_2, F_1, F_2, H_1, H_2, J_1, J_2, K_1, K_2	48,600	65,400	33	.20	.59	.010	.025	.15
22″ O.D. x .213″ Run Pipe used in Test Series No. 2	A_1, A_2, B_3, C_3, F_3, H_3, H_4, J_3, K_3	57,500	71,000	32	.23	.90	.013	.033	<.05
22″ O.D. x .312″ Run Pipe used in Test Series No. 3	A_4, D_1, E_2, G_2	60,500	74,800	24	.26	.91	.015	.037	<.05
	A_3, C_4, E_1, F_4, G_1	63,500	77,000	31	.28	.92	.016	.034	<.05
	A_5, E_3, J_4, J_5	63,800	89,000	30	.31	1.14	.015	.027	—
Branch Pipe, Tees, Saddles and other Reinforcements	.....	35,000 —58,000	62,000 —78,000	25 —41	.13 —.30	.35 —.86	.010 —.025	.022 —.049	<.05 —.24

pressure-pulsation tests is shown in Figure 2. Briefly, the operation was as follows. The specimens were water filled and air vented, and then connected through a header to the discharge end of a reciprocating pump.

The pump was started. As soon as the pressure reached a preselected maximum, a pressure-control switch opened a bypass valve allowing discharge into a storage tank connected with the pump suction; as soon as the pressure dropped to a preselected minimum, another pressure-control switch closed the by-pass valve allowing the pressure to rise again, and the cycle was repeated.

Each cycle operated a counter. Failure of any one of the specimens caused the pressure to drop below the preselected minimum, at which time a low-pressure cutoff switch automatically shut down the entire apparatus, the counter reading indicating the cycles to failure.

The upper limit was set around 90 percent of the calculated yield pressure of the run pipe; lines are often tested to this pressure and it might also be attained as a result of pulses. The lower limit used was of the order of one-half the yield pressure. While pressure variations of this order of magnitude are probably not frequent in actual service, they were considered necessary to produce failure in a reasonable length of time.

Table 1 shows the actual values of the pressure ranges used in three distinct series, as also the corresponding stress ranges (calculated from the Barlow formula based on nominal OD and thickness) in the run pipe.

The first series comprises the model tests; the full-scale tests were broken down into two series to account to some extent for the differences encountered in the physical properties of the run pipe furnished.

The cycling rate in these tests varied from 2 to 25 cycles per minute, depending principally upon the number and size of test specimens being tested simultaneously. It is a well established fact that, below a certain frequency well above the range involved here, the cycling rate exerts no noticeable effect on fatigue life.

In general, tests were discontinued after a specimen had withstood 250,000 cycles in the model tests or 500,000 in the full-scale tests, these limits being a multiple of the cyclic life of saddle reinforced connections.

The testing medium was water, with the temperature varying from about 75° F. to 150° F.

Test specimens. General views and enlarged sections of significant details of the basic variants tested are given in Figure 3. In drawing the sections, an attempt has been made to show clearances and weld contours as they actually existed.

All variants may be considered to be derivatives of Type A, rolled-and-welded pipe, inasmuch as diameter, thickness, length and end closures are always the same. All reinforcements, except those for Types J and K, are built around the unreinforced intersection, Type B.

Figure 3 gives the dimensions for the full-scale specimens. In the models, all dimensions were scaled down to 58 percent of the full-size dimensions; as an example, the run pipe of the models was 12¾-inch OD x .188-inch nominal wall as compared with 22-inch OD x .312-inch for the full-scale assemblies.

The material for the run pipe of the full-scale specimens was specified as API-5LX-52, whereas that for the models was ASTM A106, Grade B; physical and chemical properties for each length are given in Table 2.

Welding was done by two experienced welders who had spent the majority of their working time in the past three years at the job of welding piping test assemblies, and it is believed that the welds produced are comparable to field installations of good quality.

Test results. A first quantitative yardstick of the relative performance of the different variants tested is given by the number of cycles each sustained before failure.

However, since two sizes were involved, models and full-scale, and

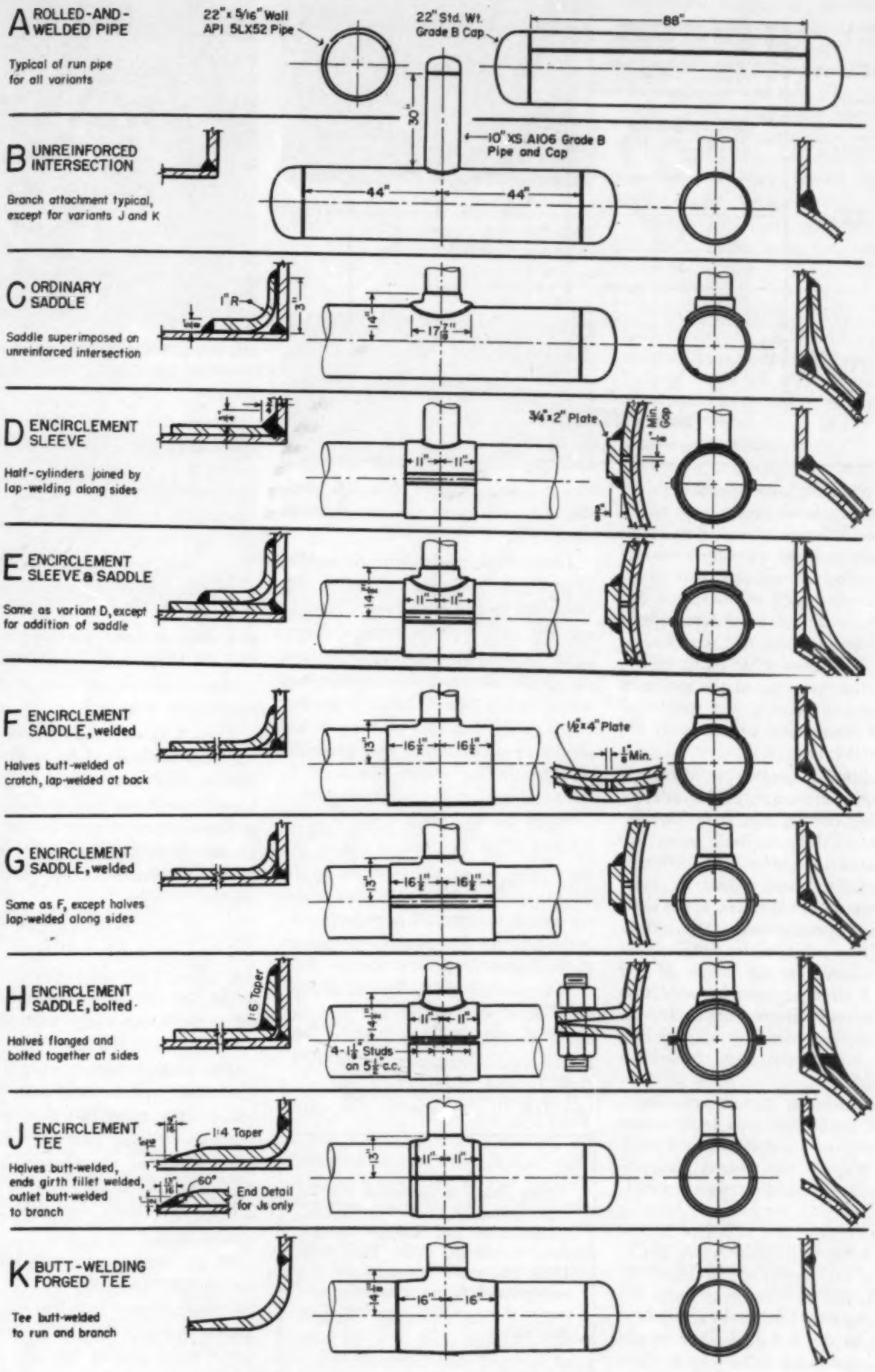

A ROLLED-AND-WELDED PIPE
Typical of run pipe for all variants
22" x 5/16" Wall API 5LX52 Pipe
22" Std. Wt. Grade B Cap
88"
30"
B UNREINFORCED INTERSECTION
Branch attachment typical, except for variants J and K
10" XS A106 Grade B Pipe and Cap
44"
44"
C ORDINARY SADDLE
Saddle superimposed on unreinforced intersection
1" R
17 7/8"
D ENCIRCLEMENT SLEEVE
Half-cylinders joined by lap-welding along sides
11"
11"
3/4" x 2" Plate
Min. Gap
E ENCIRCLEMENT SLEEVE & SADDLE
Same as variant D, except for addition of saddle
F ENCIRCLEMENT SADDLE, welded
Halves butt-welded at crotch, lap-welded at back
16 1/2"
16 1/2"
1/2" x 4" Plate
1/8" Min.
G ENCIRCLEMENT SADDLE, welded
Same as F, except halves lap-welded along sides
H ENCIRCLEMENT SADDLE, bolted
Halves flanged and bolted together at sides
1:6 Taper
4-1 1/8" Studs on 5 1/2" c.c.
J ENCIRCLEMENT TEE
Halves butt-welded, ends girth fillet welded, outlet butt-welded to branch
1:4 Taper
60°
End Detail for Js only
K BUTT-WELDING FORGED TEE
Tee butt-welded to run and branch
16"
16"

FIGURE 3—Typical dimensions of full-scale test specimens.

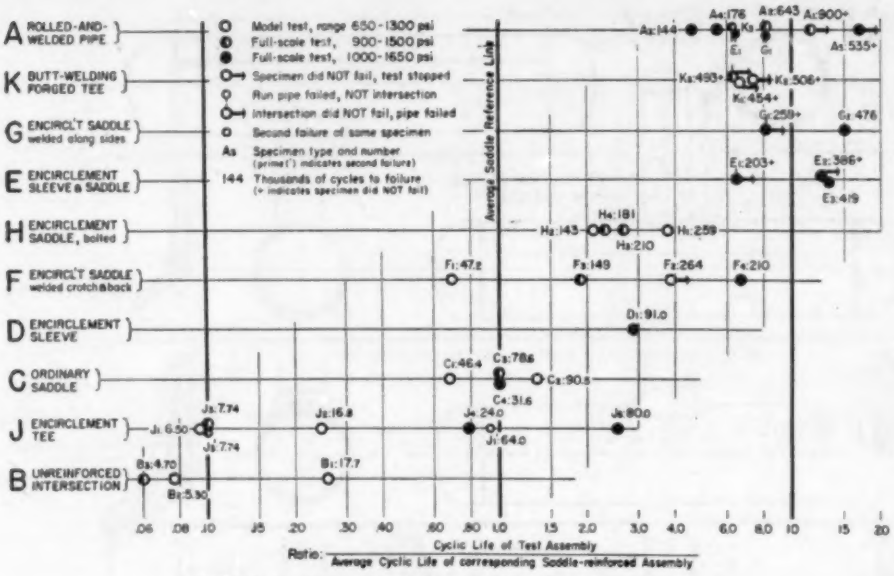

A ROLLED-AND-WELDED PIPE
K BUTT-WELDING FORGED TEE
G ENCIRCLET SADDLE welded along sides
E ENCIRCLEMENT SLEEVE & SADDLE
H ENCIRCLEMENT SADDLE, bolted
F ENCIRCLET SADDLE welded crotch & back
D ENCIRCLEMENT SLEEVE
C ORDINARY SADDLE
J ENCIRCLEMENT TEE
B UNREINFORCED INTERSECTION
Model test, range 650-1300 psi
Full-scale test, 900-1500 psi
Full-scale test, 1000-1650 psi
Specimen did NOT fail, test stopped
Run pipe failed, NOT intersection
Intersection did NOT fail, pipe failed
Second failure of same specimen
As Specimen type and number (prime (') indicates second failure)
144 Thousands of cycles to failure (+ indicates specimen did NOT fail)
Average Saddle Reference Link
Cyclic Life of Test Assembly
Ratio: Average Cyclic Life of corresponding Saddle-reinforced Assembly

FIGURE 4—Comparison of cyclic life of variants tested.

specimens of the latter group required subdivision into two sub-groups to account for differences in yield strength, this yardstick is not a precise measure.

Evaluation accordingly was made separately for each of the three test series characterized by different pressure ranges, and the test results were plotted in Figure 4 in terms of the ratio of the cyclic life of the specimen in question to that of the saddle reinforced connection subjected to the same pressure range.

The different basic types of branch connections are arranged in order of decreasing life in Figure 4. The results obtained from each series are represented by circles with different markings. Secondary results, i.e., such which should not be given full weight in making comparisons, are shown by small circles; this relates to pipe failures produced in the course of the test of a stronger branch connection and to second failures of encirclement tee connections after the original failure, in a different weld, had been repaired.

As anticipated, the straight pipe, Type A, lends itself well as an upper aim point, and the unreinforced intersection, Type B, sets a lower performance limit; the saddle reinforced connection, Type C, our yardstick because it is the construction all other designs are intended to improve upon, lies in between. The forged butt-welding tee, Type K, did not fail in a single instance and thus justifies its recognized position as the full equivalent of the pipe it is intended to match; the lap-welded encirclement saddle, Type G, and the encirclement sleeve-and-saddle, Type E, gave similar performance.

The bolted encirclement saddle, Type H, the encirclement saddle split along the crotch and back, Type F, and the plain encirclement sleeve, Type D, all are improvements upon the saddle, but not the equivalent of unperforated pipe. The encirclement tee, Type J, finally, has been found erratic in performance and generally inferior to the saddle, contrary to expectations.

These are the facts. Can they be reconciled by the use of logic? An attempt to do so will be made in the following, in conjunction with a discussion of variants of construction of individual specimens and the nature of the failures experienced.

When rolled-and-welded steel pipe, Type A of our list of test variants, failed at all, the crack always occurred in a longitudinal direction. Only in one instance did the weld itself fail. In all others the split paraleled the seam, following one of several shallow grooves observable in the outer surface of the pipe; in the one instance where the split was short, specimen A_2, it was noted that both length and width of the crack were greater on the outside than on the inside, clearly indicating that failure started at the outside.

Figure 5 shows an over-all view and close-up of such a typical failure in resistance welded pipe. The large spread in cyclic life between specimens, one specimen splitting in 144,000 cycles and another running for 900,000 cycles without failure, probably reflects the presence and severity of either mechanical or metallurgical notches.

Where failure did occur, the life ratio as referred to the saddle reinforced connection was relatively consistent, an observation which tends to support the validity of the basis used for correlating data from different series.

The unreinforced intersection, Type B, failed either by cracking across the weld in the crotch, or along it at the side, both types of failure being experienced simultaneously in one assembly. See Figure 6.

This is in accord with strain gage test results obtained by other investigators: for connections where the branch size is one-half that of the run or less, the maximum principal stresses are nearly uniform around the perimeter of the intersection, only their direction changes.

In the case of the intersection reinforced with an ordinary saddle, Type C, the run pipe invariably split along the side flange of the saddle. An over-all view of a typical failure is shown in Figure 1B.

The encirclement sleeve, Type D, fractured through the crotch weld, releases a fine spray of water. Both the test variant itself and the failure encountered bear close resemblance to the unreinforced intersection, but the average life ratio was found to be related as 22:1.

By the approximate correlation between endurance strength and cycles-to-failure suggested by the senior author in a paper on bending fatigue,[1] this would imply that the ½-inch thick sleeve served to reduce the criti-

This article is condensed from a paper presented at the Gas Supply, Transmission and Storage Conference, Pittsburgh, Penn., May 9-10, 1955. The views expressed are the authors' and do not necessarily represent those of the American Gas Association.

FIGURE 5A—Failure of rolled-and-welded pipe (Type A). General view of split in pipe.

FIGURE 5B—Failure of rolled-and-welded pipe (Type A). Detail showing fracture along weld seam.

cal stress to 54 percent of the value without this reinforcement; this estimate would appear reasonable.

In the sleeve-and-saddle reinforcement, Type E, the two preceding types of reinforcement are used to complement each other, and as a result excellent performance is achieved. Of a total of three specimens tested, two failed in the pipe run outside the reinforcement, E_1 due to fatigue and E_2 from accidental over-pressuring; E_3 failed under the sleeve, the fatigue crack following the edge of the weld flash line in the carrier pipe.

The three variants of the encirclement saddle, Types F, G, and H, will be discussed at the same time on account of their close similarity in intersection detail. All of these would be expected to give about equal performance to the sleeve-and-saddle design which they resemble in the essential details, except that the outlet half of the latter is of two-piece construction.

Actually only Type G consistently came up to the same high standard. In one of the specimens, the intersection did not fail at all, the pipe itself rupturing beyond the zone of reinforcement; in the other, it took a multiple of the number of cycles which had caused failure in some of the corresponding straight pipe tests before a crack appeared in the crotch zone of the intersection.

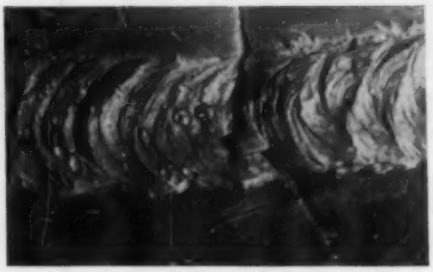


FIGURE 6A—Failure of unreinforced intersection (Type B). Transverse crack through crotch of intersection.

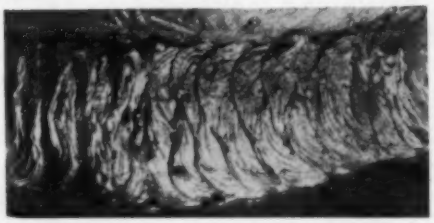


FIGURE 6B—Failure of unreinforced intersection (Type B). Crack along weld toe at side in same specimen.

The performance of Type F, which is distinguished only by a different plane of cut between the two reinforcement halves, was somewhat erratic. In the model tests, specimen F_1 developed a leak coming from under the reinforcement in 47,200 cycles. In order to be able to continue the test, both ends of the reinforcement were fillet welded to the pipe run, but the assembly only sustained an additional 5,500 cycles before the crotch weld joining the two halves cracked. This somewhat difficult weld had been made in the normal way, without backing.

To insure a sound weld, a thin curved backing strip was used at this location in all further tests, and probably as a result of this provision, the second model survived 264,000 cycles without failure. One of the full-scale specimens also showed a fair life, while the other performed only moderately better than a saddle, both failing at the crotch of the intersection between branch pipe and run pipe.

Inasmuch as the construction of Type F departs from that of Type G in only one particular, i.e., the location of the seams joining the semi-cylindrical halves of the reinforcement, the difference observed in the performance of the two variants might be explained on the theory that shrinkage of the two side welds in Type G in some way produces a tighter fit-up in the critical zone than is the case where the closing weld is made at the back, remote from the outlet, as in Type F.

However, if there were differences in fit-up, these were not discernible upon inspection of the failed assemblies.

The bolted variant, Type H, similarly only provided moderate improvement over the ordinary saddle. Failure, as in all encirclement types of reinforcement discussed heretofore, occurred in the crotch of the run-to-branch intersection. With the thought that close contact of the saddle with the branch-to-run intersection weld might have a beneficial effect, intentional variables in the detail fit-up at this location were introduced, but, as is evident from Figure 4, no marked effect on relative life of the different specimens was produced.

This design evolved from the thought that bolts should provide an excellent means of bringing the reinforcement into forcible contact with the pipe; however, in the design actually tested a substantial bolt moment was introduced which "kicked in" the pipe at the sides and apparently defeated the purpose.

Coming finally to the two alternate applications of welding tees, the first result of significance is that the tee itself failed in neither. The assemblies of Type K, where a standard tee was butt-welded to both run and branch pipe in a conventional manner, gave excellent performance; the full-scale test, in particular, was terminated by the rupture of the carrier pipe, with the tee left unharmed. It is apparent that its inherent reinforcement and smooth contouring make the tee the full equivalent of the pipe it is designed to match.

The assemblies of Type J, where the tee surrounds the carrier pipe and is filet-welded thereto, on the other hand, gave an unexpectedly poor account of themselves. With the exception of the initial failure in the first model, J., where the butt-weld joining the two halves cracked in only 6500 cycles, all failures occurred in the fillet welds at the run ends, the

location in all except one instance being directly in line with the crotch.

The entire assemblies, including the fillet welds in all but the last specimen, J_5, had been proportioned to parallel the assembly used by Del Buono, Vissat and Williams in their exhaustive and evidently very carefully conducted strain gage tests.[2] It is noteworthy that failure in the authors' tests occurred in the precise location where these investigators had obtained the highest strains, and that the crack closely resembled that found by them upon sectioning through the crotch plane after bursting.

Since the weld quite obviously constituted a point of weakness, the thought naturally presented itself that the performance of this design could be improved by increasing the weld size. Accordingly a special assembly, specimen J_5, was made up using what was considered a maximum practical weld size: the weld leg dimension was increased by more than 50 percent and the tee end was machined with a reverse bevel of 60 degrees and a 3/16-inch root radius to approach butt-welding conditions, all of which resulted in over 150 percent increase in the amount of weld metal deposited. Using the same correlation rule as employed earlier in comparing the sleeve-reinforced design to the unreinforced intersection, the 50 percent increase in weld throat dimension would have led to an estimate of a life ratio of the order of 7½ in comparison with the original design; actually the design with the heavier weld lasted only 3¼ times as long as one with the original weld proportions tested under otherwise identical conditions.

Summary and conclusions. The investigation was undertaken with the intent of evaluating the relative performance of different types of branch reinforcement. To assure that the tests would be meaningful, a careful examination was first made into possible causes of field failures of saddle-reinforced intersections which have aroused concern throughout the pipe line industry. This study led to the deduction that failures were associated with stress concentrations, either those inherent in the intersection geometry or such introduced in the process of welding.

It being a well-known fact that stress intensifications have little influence on the failure of a part under static loading, it became evident that cyclic stress must have been a factor; and that cyclic tests would be best suited to locating points of weakness, whether due to design, material, welding or fit-up.

Among cyclic tests, the pulsating pressure test appeared preferable to tests wherein either a bending moment or an axial pull is applied to the branch pipe because it loads the entire intersection area in all directions.

The tests were directed primarily at evaluating the more recently developed types of encirclement reinforcement, but straight pipe, unreinforced intersections, ordinary saddles and conventional butt-welding tees were also tested to provide yardsticks for comparison. In addition to full-scale assemblies using line pipe ordered to API Specification 5LX52 for the run, models constructed of ASTM A106, Grade B pipe were tested, the intent being to ascertain whether underbead cracking was a necessary constituent of failure.

No evidence of such an effect was detected, perhaps because the line pipe furnished was not excessively high in carbon and manganese content, the models giving the same relative results as the full-scale specimens.

The test results were unexpectedly consistent, considering the unavoidable variables introduced during assembly. The different specimens of any one type failed in the same order of cycles and generally in identical locations, these being either known or anticipated points of maximum stress. This justifies the conclusion that the basic design or geometry of any specific type is the primary factor governing its performance.

It is probable that weld defects played a contributory role in that some of the cracks observed originated in, or followed along, weld irregularities, such as imperfectly fused roots, unusually deep cover pass ripples, or weld edge undercuts. But in view of the notable consistency in location and direction of cracks, the effect of welding must be adjudged secondary, at least in the present tests; under unfavorable field conditions, it is quite conceivable that weld quality may assume a controlling role.

Because failure appeared to be governed by basic geometry, it was possible to establish a definite scale of merit for the different designs tested, despite the limited number of tests of each type. While it would be extravagant to state that the results of a relatively small number of tests on a single combination of pipe sizes and thicknesses should be taken as conclusively establishing the superiority of one design over another, they are strongly indicative of fundamental differences in performance, at least under the loading considered.

Certain designs were found to be on a par with straight pipe or its equivalent, the butt-welding tee. Others were somewhat less effective, but still constituted improvements over the ordinary saddle which, it should be remembered, has proved adequate in the majority of field applications. Only one type of encirclement reinforcement, the encirclement tee, proved disappointing in these tests in that its average performance did not equal that of the saddle.

While the relative position of different types in the scale of merit could be rationalized in most instances, no fully adequate explanation can be offered why two variants of the encirclement saddle gave inferior performance as compared to the third. It is surmised that the location of the cut lines and manner of joining the two halves may have influenced the degree of fit-up obtained, but careful examination produced no direct evidence.

All encirclement reinforcements failed in the form of fine hair cracks which did not grow at a noticeable rate under additional pulsations. While it is possible that these might open up more under the influence of gas pressure than with water as used in these tests, there is reason to believe that these types would not be as prone to complete failure as a saddle.

With regard to the question whether the cycles-to-failure obtained in these tests could be applied to provide an estimate of service life, the authors feel that this could be done on a purely comparative basis, using experience with saddles as a base line.

ACKNOWLEDGMENT

The extensive investigation communicated herewith presents a contribution of Tube Turns, Louisville, Ky., to the pioneering work of the A.G.A. Supervisory Committee for Branch Connection Research, whose membership has contributed greatly to the value of this paper through comments on a preliminary draft.

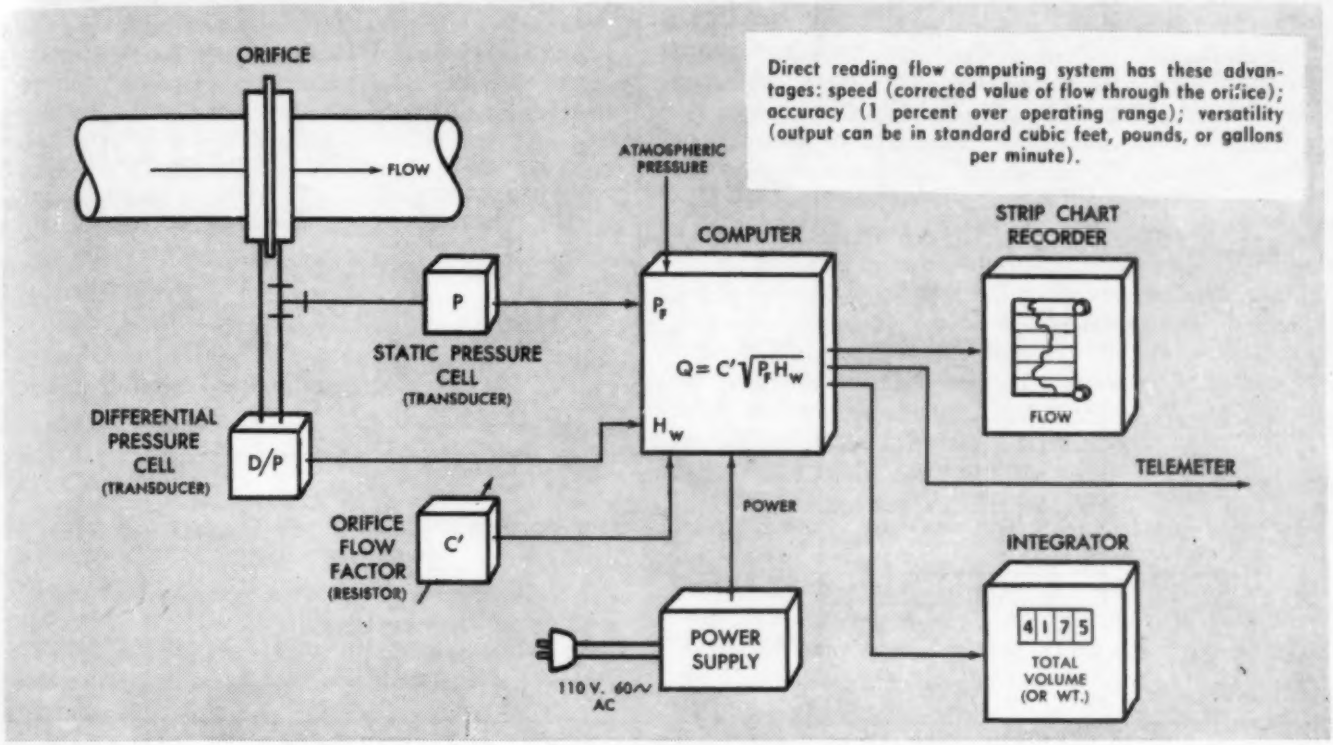
REFERENCES

[1] Fatigue Tests of Welding Elbows and Comparable Double-Mitre Bends by A.R.C. Markl. Trans. A.S.M.E., Vol. 69, No. 8; specific reference is to equation (3) which states that the endurance strength is inversely proportional to the fifth root of the number of cycles.

[2] Design of Hot Tap Tee Connections in High-Pressure Pipe Lines by A. J. Del Buono, P. L. Vissat and Frank S. G. Williams, Paper No. 53-PET-31 presented at the Petroleum Division Conference of the ASME, Houston, Sept. 28-30, 1953.

—The End

DIRECT READING ORIFICE METER IS MOST ACCURATE YET



Direct reading flow computing system has these advantages: speed (corrected value of flow through the orifice); accuracy (1 percent over operating range); versatility (output can be in standard cubic feet, pounds, or gallons per minute).

Meter of the Future Is Here

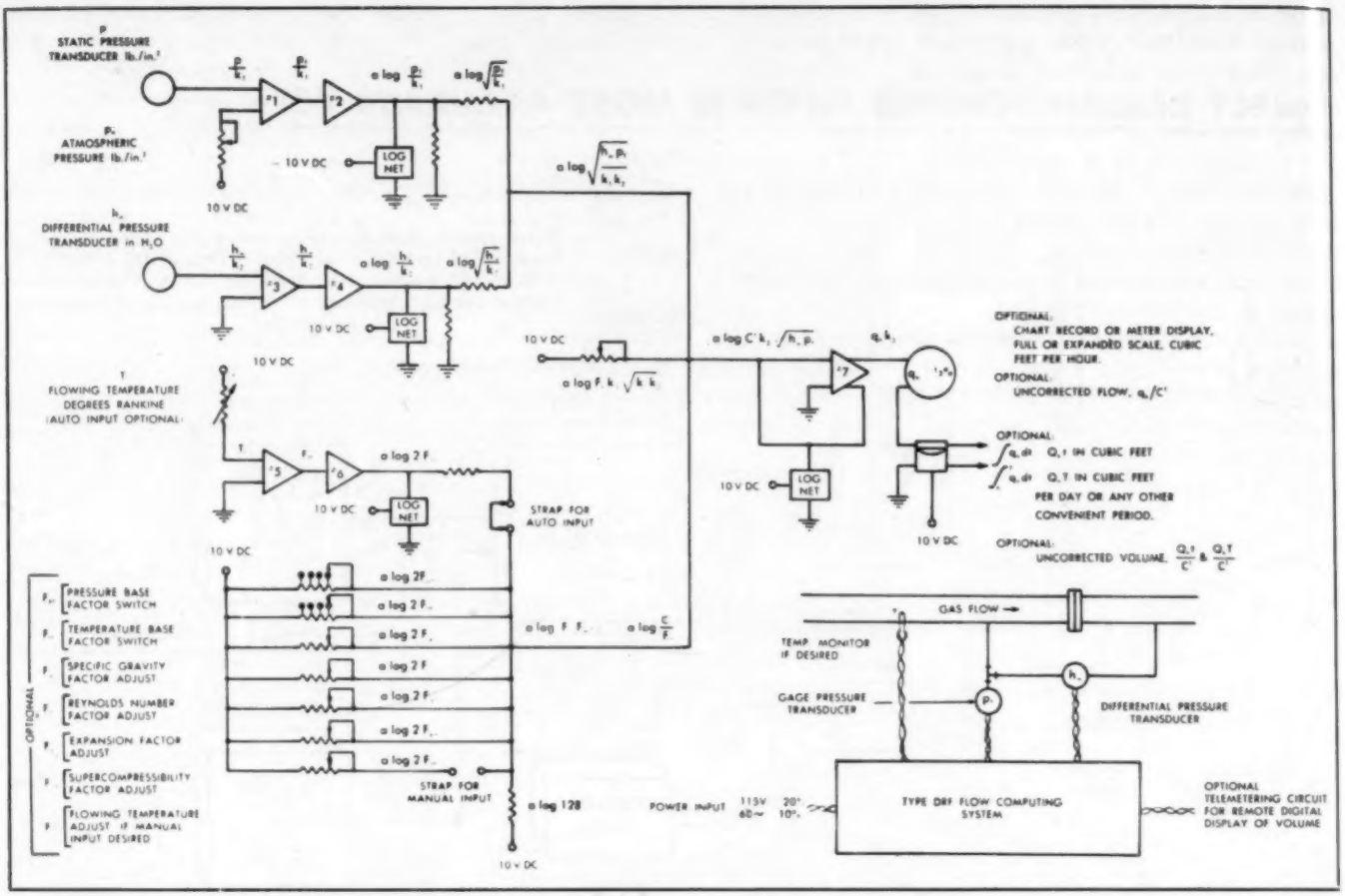
New type analog computer calculates volumes from differential and static pressures, temperatures, specific gravity . . . records and totalizes in gpm and cfm.

By FRANK C. SMITH, JR., Southwestern Industrial Electronics Company, Houston

INCREASED ACCURACY and speed in orifice meter flow measurements are made possible by a new analog computer especially designed for this purpose. It requires little power, is compact and rugged, and can be installed and maintained in the field by non-technical personnel.

The significant difference between this and previous orifice flow measurement systems lies in the fact that this device computes corrected flow as the data (differential pressure, static pressure, temperature, etc.) are fed in. Other systems record these data for subsequent computation. The advantages of continuous simultaneous computation are:

1. The computed and corrected flow figures are instantly available, thereby making possible automatic control through a feedback loop.
2. The sensing devices and the computing unit are able to follow pulsations up to 500 cycles per minute. The recorder will then make an accurate graph of the true average flow in standard units, without "painting" the chart.
3. It is necessary to record the input variables—static pressure, differential pressure, temperature, etc., individually. This eliminates manual computing and integrating processes. The computer provides a direct indication of flow, and also may be supplied with an accumulating totalizer or integrator simultaneously indicating true volume.
4. Corrected computations may be continuously recorded on strip charts without the possibility of human error at any stage. Frequent chart changing, visual reading, manual correcting and integrating are not necessary. Errors due to pulsations, chart shrinkage, etc. are eliminated.
5. The output of the computer may be directly connected or telemetered to dispatching stations and central accounting offices.


STATIC PRESSURE TRANSDUCER lb./in.²
ATMOSPHERIC PRESSURE lb./in.²
DIFFERENTIAL PRESSURE TRANSDUCER in H₂O
FLOWING TEMPERATURE DEGREES RANKINE (AUTO INPUT OPTIONAL)
10 V DC
LOG NET
STRAP FOR AUTO INPUT
STRAP FOR MANUAL INPUT
OPTIONAL:
CHART RECORD OR METER DISPLAY, FULL OR EXPANDED SCALE, CUBIC FEET PER HOUR.
OPTIONAL:
UNCORRECTED FLOW, q_h/C'
OPTIONAL:
Q_1 IN CUBIC FEET
Q_2 IN CUBIC FEET PER DAY OR ANY OTHER CONVENIENT PERIOD.
OPTIONAL:
UNCORRECTED VOLUME, $\frac{Q_1}{C'}$ & $\frac{Q_2}{C'}$
OPTIONAL
PRESSURE BASE FACTOR SWITCH
TEMPERATURE BASE FACTOR SWITCH
SPECIFIC GRAVITY FACTOR ADJUST
REYNOLDS NUMBER FACTOR ADJUST
EXPANSION FACTOR ADJUST
SUPERCOMPRESSIBILITY FACTOR ADJUST
FLOWING TEMPERATURE ADJUST IF MANUAL INPUT DESIRED
GAS FLOW
TEMP. MONITOR IF DESIRED
GAGE PRESSURE TRANSDUCER
DIFFERENTIAL PRESSURE TRANSDUCER
POWER INPUT 115V 20^ 60~ 10^
TYPE DRF FLOW COMPUTING SYSTEM
OPTIONAL TELEMETERING CIRCUIT FOR REMOTE DIGITAL DISPLAY OF VOLUME

Schematic of the analog computer flowmeter. Note the many optional factors, at left, which can be fed into the system. The output of the computing system can be fed into control instruments as desired.

Based on new developments. The flow computing system, which was conceived and designed by D. P. Gregg of Southwestern Industrial Electronics Company, is based on several new developments. The introduction of accurate and reliable sensing devices, or "transducers," which use no mercury and convert pressures into electrical signals, made possible the use of electrical computing techniques to flow measurement. These transducers have been in actual fulltime operation in several large field installations for over a year and have compiled excellent records. Secondly, mass production of computer-grade semiconductor diodes for large business and military computing machines made these components readily available, dependable and inexpensive.

The third important link was added with the development of linear high-gain magnetic amplifiers, which are used in the computing unit, in place of vacuum tubes. Magnetic amplifiers have unlimited life, are immune to shock, vibration, and temperature effects, and consume only a fraction of the power required by vacuum tubes. The availability of all these components made the development of a single-purpose analog computer for field use practical for the first time.

Significance of accuracy. Several statements made above with regard to accuracy should be more fully explained. An important point is that the computer maintains its accuracy within 1 percent of point value at any instant, throughout its dynamic and frequency ranges. This means that if no pulsations higher than 500 cycles per minute are present in the line, and the static and differential pressure do not fall below one-tenth of their maximum values, the indicated value of flow will be within 1 percent of the true value. This is an improvement of at least 2 to 1 in accuracy and dynamic range, and several hundred times in frequency response, over conventional techniques.

As all of the errors can be either positive or negative, however, the total volume error over a long period of time is expected to be less than .1 percent.

Only the complete elimination of human and chart errors in the computing process could achieve accuracy to this degree, and no other system eliminates these variables. It should be pointed out that it is the transducers, indicators, and chart recorders which limit the accuracy of the system. The computer itself is capable of short-term accuracy in the order of .1 percent, and long-term .01 percent accuracy.

Pipe line applications. By its very nature, natural gas is a difficult commodity to measure. It is affected by so many variables, and must be measured under so many different conditions, that many schemes for its measurement have been proposed.

The most widely accepted method of measuring gas flow in large quantities involves generating a differential pressure, usually by means of an orifice plate. However, the differential pressure itself is not a direct and accurate indication of the flow. According to the AGA, flow through an orifice is given by the formula: $Q_h = C'\sqrt{h_w p_f}$, where C' is the orifice flow contant, h_w is the differential pressure, in inches of water, and p_f is the absolute static pressure, in pounds per square inch. C' is the product of

factors representing the orifice, the pressure base, the temperature base, the specific gravity, the flowing temperature, the Reynold's number, the expansion factor, and the supercompressibility. Some of these vary rapidly, some slowly, and some are constant for a given installation.

It has been standard practice for years to compute the value of gas flow from these factors by means of a variety of mechanical, pneumatic, and manually-operated devices. Until the development of accurate pressure-to-voltage transducers, electrical solutions could not be conveniently applied to the problem. Now, however, at least four types of suitable transducers are available which will work into an electrical computer. In addition to a number of minor advantages which will be mentioned later, the electrical computer does three things which make it vastly superior to any other device. These are:

1. It computes in real time—that is, it indicates the corrected value of flow at the instant the gas is flowing, making automatic control possible.
2. It makes it possible to include any or all of the above-mentioned corrections, exactly as prescribed by the AGA equation.
3. Its high frequency response enables it to compute pulsating flow as the pulsations occur.

For all practical purposes the pressure pulsations in a pipe line may be considered to be sinusoidal. Consider an average differential pressure h_a, on which is superimposed a sinusoidal pulsation of peak amplitude h′. The instantaneous pressure is then

$$h_w = h_a + h' \sin 2\pi ft$$

Assuming static pressure and all other parameters to be constant, the time average flow is

$$Q = C\sqrt{h_w} = \frac{C}{2\pi}\int_0^{2\pi} \sqrt{h_a + h' \sin 2\pi ft}\, dt$$

$$= \frac{C\sqrt{h_a}}{2\pi}\int_0^{2\pi} \left(1 + \frac{h'}{h_a} \sin 2\pi ft\right)^{1/2} dt$$

Now if we are using a damped manometer, $Q = C\sqrt{h_a}$. Therefore the pulsation error factor is

$$\frac{1}{2\pi}\int_0^{2\pi} \left(1 + \frac{h'}{h_a} \sin 2\pi ft\right)^{1/2} dt$$

which can be expanded by

$$\frac{1}{2\pi}\int_0^{2\pi} \left[1 + \frac{h'}{2h_a}\sin wt - \frac{h'^2}{8h_a^2}\sin^2 wt + \frac{3h'^3}{43h_a^3}\sin^3 wt - \frac{15h'^4}{384h_a^4}\sin^4 wt \ldots\ldots\ldots\ldots\right] dt$$

This can be integrated to give $1 - \frac{1}{16}\left(\frac{h'}{h_a}\right)^2 \ldots\ldots\ldots\ldots$

all terms above second order being negligibly small.

From this, an error table may be computed, as follows:

Percent Pulsation	Correction Factor*	Percent Error
$\frac{h'}{h_a} \times 100$	$\left(d - \frac{h'^2}{16h_a^2}\right)100$	
1	99.999	0.0006
2	99.998	0.0025
5	99.984	0.016
10	99.938	0.063
20	99.75	0.25
50	98.43	1.56
100	93.75	6.25

*Sometimes called "supercompressibility" factor.

In gas flow, pulsation error may be increased by two additional variables. The static pressure may also pulsate, and the two pulsations may be out of phase. The phase angle is analogous to electrical power factor.

One further aspect of pulsating flow should be considered. If pulsations are present in a manifold, an orifice meter on a branch line will experience pulsations, even if a valve beyond it is closed so that the net flow through the orifice is zero. The SIE system, like a conventional flowmeter, will rectify this pulsation and give an erroneous reading. If it is desired to measure such a situation accurately, however, two systems can be connected back-to-back, each measuring the flow in one direction, and the resulting currents subtracted to show true flow.

The majority of orifice installations on gas pipe lines are in the vicinity of compressor stations, which makes it particularly desirable for the equipment to measure accurately in the presence of pulsations. The power supply of the computer was also designed with such installations in mind, as it will operate on 110 volt 60 cps AC, and is not critical with regard to either voltage or frequency. It is desirable to locate the computer fairly close to the orifice, but the indicating and recording units may be several thousand feet away, connected only by a two-wire, very low-voltage circuit.

The recommended indicating device is a fan-type milliammeter with seven-inch scale, calibrated in cubic feet or pounds per minute over the operating range. A strip-chart recording milliammeter may be used to make a permanent record of flow rate, while volume is read on a digital counter. The indicating system is analogous to an automobile speedometer with a resettable odometer. Both of these indicators may also be used as control elements; for example, the flow indication may be used to control valves or compressors to hold flow at a predetermined rate regardless of pressure variations, or the totalizer may be used to close a valve when a certain weight or volume of gas has passed through the orifice. These functions are especially applicable to blending operations.

One of the most important features of the flow computer, however, for compressor station installations, is its ease of maintenance. Unskilled personnel can check its accuracy within a few minutes, using only one simple test instrument. All units subject to error or failure are easily replaceable, but it is extremely unlikely that failure will occur because there are no moving parts or vacuum tubes, and the whole unit can be hermetically sealed.

The rotary converter which supplies power to the computer and transducers has no brushes or starting switches, and will require bearing maintenance no more than once a year. The transducers are equally durable, and the strip-chart recorder will require paper and ink less often than the usual circular-chart type.

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ACKNOWLEDGMENT

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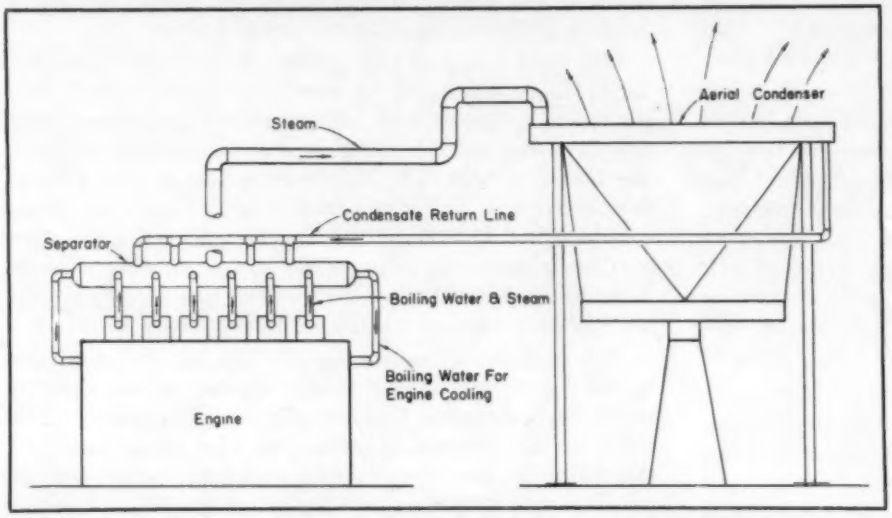
—The End

COOLING ENGINES WITH BOILING WATER



Here is how boiling water is circulated to cool an engine. Water and steam rise from the cooling water jackets to a horizontal separator, where steam is flashed off and goes to an air-cooled condenser. Condensate returns to the separator to take more heat from the steam and maintain condensate temperature at the boiling point. Cooling water—still at the boiling point—is returned to the jackets to cool the engine.

Operation Teakettle

Vapor phase cooling of internal combustion engines is one answer to the gas industry's problem of reducing capital investment and lowering operating costs.

By BROCK MOTT, The Mott Company, Houston

AN EVOLUTION IN the cooling of internal combustion engines is resulting in improved engine maintenance, reduced fuel and lubricating oil consumption, lower auxiliary power requirements, and substantial savings all of real interest to the gas industry. While most improvements to equipment result in higher first cost, these beneficial effects are actually possible at a reduced installed cost of cooling system.

Tracing this evolution, first look at the heat dissipation of modern internal combustion engines. Less than a third of the total energy of the fuel is converted into useful work. Another third goes out the exhaust to the atmosphere, while the remaining third is rejected to the metal encasing the combustion chamber. This heat rejected to the metal must be carried away efficiently to preserve the conformation and design clearances of internal moving parts without deterioration of the lubricant. This basic cooling concept emphasizes the importance of maintaining uniform metal temperatures, rather than maintaining any arbitrary coolant temperature level. Some of this heat is transferred from friction parts to the lubricating oil, but the larger portion is dissipated through the liner wall and cylinder head to power cylinder jacketing containing water coolants.

Uniform metal temperature important. Some engine designers apparently lost sight of these basic cooling requirements of their machines, since not many years back it was common practice to cool engine jacket water to 120° F. or less, with a temperature rise across the jackets in excess of 25° F. High metal stresses resulted from the cold jacket metal restraining expansion of the hot cylinder parts, and unequal expansion between bottom and top cylinder. With the advent of aerial cooling some 15 years ago, engine designers were forced to higher jacket temperatures and reduced cooling ranges to keep cost of cooling systems down. Engines performed as well at these higher temperature levels. In fact, the higher temperatures reduced crankcase sludging, with consequent improved lubrication and less wear on moving parts. Lower temperature differentials across the jackets contributed to fewer cracked heads and liners which apparently was due to reduced metal stresses and more uniform expansion of hot metal.

It is fairly accepted practice today to cool engine jacket water from 170° F. to 160° F. Although a few operators still take exception to these temperatures, many are more inclined to strive for even higher temperatures and lower rise for the benefits so derived. Vapor phase cooling carries this trend to its ultimate objective, using heat absorption without temperature rise.

Vapor phase cooling. The term "vapor phase" cooling is somewhat misleading in that it implies that jacket cooling is accomplished by vapor being circulated in the jackets. Actually, the jackets are full of water, and only a relatively small amount of steam is generated. More descriptive terms are boiling point cooling, latent cooling, and ebullient cooling. By permitting the jacket water to boil in the jackets, the engine is cooled by the latent heat absorption capacity of the water. So, if the water is introduced to the system at the boiling point, it absorbs the heat from the hot metal surfaces by partial evaporation without significant change in temperature. Under these conditions, water temperature is automatically controlled by the pressure kept on the system. No costly three-way valves or other temperature controlling devices are required to maintain a constant coolant temperature.

Cooling water circulates automatically. The jacket water pump used with other cooling systems is eliminated. Upon start-up of a cold engine, conventional sensible heat absorption takes place with the water static in the jackets until it reaches the boiling point, at which time fine steam bubbles appear at the hotter parts of the jacket. As these bubbles detach from the wall and rise in the jackets, they promote circulation of the water out of the jackets to a steam-water separator. From the bottom of this separator, the heavier column of water returns to the jackets without intentional cooling.

Due to the difference in density of the two columns of water, a rapid circulation is induced which is more than sufficient to assure an ample supply of water in the jackets at all times.

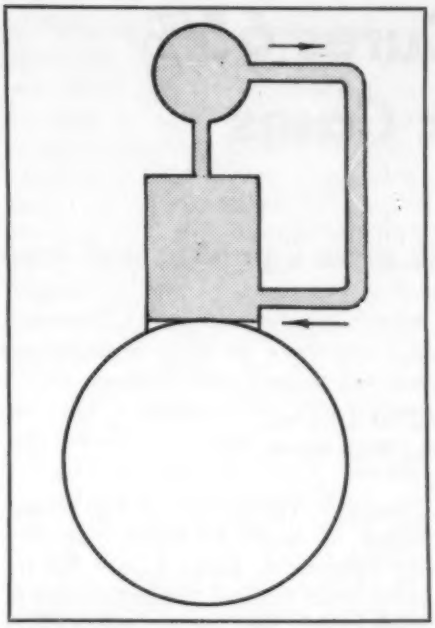
With proper design, a circulation rate of approximately 20 pounds of water per pound of steam may be maintained at full load.

You may recognize that this system is comparable to a water tube boiler, with the power cylinder jacketing serving as the tubes, and the separator as the steam drum. One significant difference is that we are circulating a higher ratio of water to steam, assuring lower heat flux and constant wetting of hot surface. If we, then, design our cooling system keeping in mind various principles of boiler design, we should end up with a workable engine cooling system.

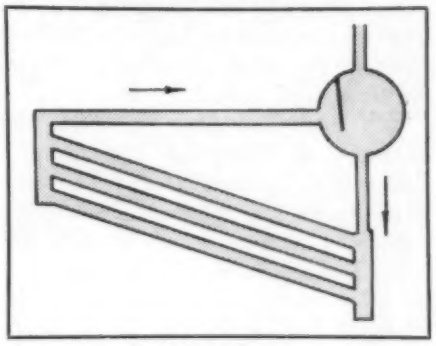
Obstructions to flow should be removed to prevent formation of steam pockets. Where lines from the jackets are not adequately sized to accommodate the volume of water and steam at atmospheric conditions, additional jumpers or larger lines should be installed. The separator should be located with as short return lines as possible, and these lines should be insulated to minimize heat loss through radiation. The steam condenser may be located either close to or away from the building, as desired. If the condenser is elevated properly, the condensate can drain by gravity back into the system, preferably to one of the water-steam headers or the steam drum in order that sub-cooled condensate may be heated back to the boiling point while condensing steam and reducing the condenser load.

Here are the advantages of the boiling water cooling system:

1. More uniform metal temperatures due to no appreciable temperature rise across engine jackets.
2. Better heat transfer to metal surrounding the jackets, thus reducing metal stresses and lessening distortion of contained hot metal parts.
3. Protection from effects of cylinder condensation, sharply reducing corrosion, and permitting use of lower grades of fuel.
4. Reduced blow-by due to more uniform expansion along the length of the liner, thus reducing lube oil contamination and oxidation rate of the oil normally caused by contact with these hot gases.
5. Improved lubrication due to elimination of sludging, and reduction in dirt load.
6. Reduced fuel and lube oil consumption.
7. Availability of waste heat at useful temperature levels.



Vapor phase cooling system works just like an oil field boiler, except an engine produces the heat instead of a fire.



Oil field boiler.

8. Greatly reduced cooling system investment.
9. Reduced utilities.

There has been much written on the maintenance and operating advantages of this cooling system; however, these advantages are intangible to an operator trying to justify installation of such a system for the first time. Actually, the system may be economically justified in almost any case by considering these three points.

Waste heat recovery. Thus far, jacket pressures with the boiling cooling system have only been carried as high as 26 pounds per square inch gage. Higher operating pressures seem feasible if design pressures of jackets will permit it. There are, however, many applications for steam at these levels. In the northern climates, winter heating of buildings is an excellent use for this steam. It can also be used in the summer in an absorption refrigeration cycle for air conditioning offices, or to chill the intake air to the engine. There are applications for this heat in oil producing areas for heating crude oil. As engine designers allow jacket pressures to be increased, more uses for this waste heat can be found.

Another interesting possibility for waste heat recovery is the exhaust heat normally dissipated to atmosphere. Steam generated by exhaust gases can be obtained from low pressures to levels as high as 200 psig. This brings up the possibility of using this higher pressure steam for jet boosting the lower pressure steam now recoverable from engine jackets.

Reduced cooling system investment and utility requirement. It is obvious that there would be a saving in heat transfer surface to cool the jacket water, because of higher overall transfer rates and higher mean temperature difference. This saving would amount to more than 40 percent of the usual aerial jacket water cooler surface needs, which represents a substantial saving in first cost. Dwarfing this saving, however, is the cumulative reduction in cost of pumps, foundations, piping, valves, temperature controls, tanks, electrical wiring, and power generating equipment. Few have stopped to consider the significance of these attendant savings which will amount to four or five times the saving realized in heat transfer surface alone.

On one recent estimate for a new compressor plant, three 1100-horsepower machines were being considered. The total dollar saving not including the cooler itself amounted to over $20,000. Saving on the cooler amounted to only about $5,000. The total saving amounted to $7.75 per brake horsepower hour. These figures do not reflect savings in power consumption and fuel, oil, and maintenance savings which would continue for the life of the installation.

The gas industry, faced with reduced margins of profit due to higher rates of federal and state taxation and control, increased operating costs, and a sale price of gas and liquid products that has not kept pace with increased overhead costs, must continue to seek means of reducing capital investment and lowering operating costs. Vapor phase cooling of internal combustion engines is one answer to this challenge.

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—The End

How du Pont Cures 65% Of Its Alcoholic Cases

A 4-part plan that gives a prudent and sympathetic approach.

By G. H. GEHRMANN, Associate Medical Director,
E. I. du Pont de Nemours and Company, Wilmington, Del.

"Every age has its problems, by solving which, humanity is helped forward."—H. HEINE.

THE ALCOHOLIC, or problem drinker, has too long been considered as a hopeless individual—weak-willed, psychotic, and in general beyond any aid that would lead to rehabilitation. He has been thrown out of industry, found himself unwelcome in general hospitals, spurned by family and friends, and allowed to shift for himself, eventually ending in skid row, a mental institution, or death.

Most industries throw him out without any attempt at rehabilitation; others waste time with threats and criticism. Too few try to understand the nature of his illness, or have any plans for a sound, sensible approach that can lead to rehabilitation.

Major Problem—Every chronic alcoholic, and often his family, is a potential burden for the taxpayers, which includes industry. It is estimated that 70 million people in this country drink alcoholic beverages, and that from 3 to 5 percent are chronic alcoholics. Thus, it should be obvious that chronic alcoholism is a major problem, one that not only warrants, but demands serious consideration.

Disease, according to our medical dictionaries, "is any deviation from the normal." Chronic alcoholism is a disease except for those who, by stretch of their imagination, consider the alcoholic a normal individual. The acceptance of alcoholism as a disease is one of the most important factors in any program of rehabilitation, more especially to the individual concerned.

During the past 40 years, the author has been associated with the DuPont Company. The protection and preservation of employes' health has been my assignment. This company has for many years realized the importance of good health, and has put much effort and money into a preventive health program. Alcoholism is one of the many phases of this program. The incidence has been no higher in DuPont than in any other group of employes, or the general public.

Up until the past 11 years, the methods of attempted rehabilitation followed the pattern of the then generally accepted methods: warnings, criticisms, sanatoria, and medical advice. The results were negligible, and, as a last resort, the employes were discharged. Sometimes they died of acute alcoholism even before discharge.

After observing the accomplishments of Alcoholics Anonymous, it was felt that here was a program that might produce better results. The then existing program results couldn't be worse, and from the angle of economics, the Alcoholics Anonymous program would be less expensive and might pay off in better dividends of employes rehabilitated. Our present plan has been successful beyond our expectations. It has been 65 percent effectual.

Any program designed to help the alcoholic must have the approval of top management, and it should be known by all the employes that the alcoholic need have no fear of losing his job, if he recognizes his disease, and takes the proper steps to overcome it. Further, every employe should understand that failure to try to help himself means discharge. There must be no exceptions to the penalty of willful failure, otherwise the plan will soon become ineffectual. Unfulfilled promises lend encouragement to further drinking.

Four-Part Plan—Our plan consists essentially of 4 parts:

1. Educational lectures to management, supervision, foremen, and workers. These lectures are given by individuals who have learned about alcoholism the hard way—personal experience—and have been successful in overcoming their disease. They are rehabilitated alcoholics. One who has never been a problem drinker fails to make a lasting impression upon his audience. The alcoholic, on the other hand, sounds the voice of experience.

Our speaker usually startles his audience into immediate attention and interest by saying, "I am an alcoholic." He follows this bold statement with an account of his history of drinking and recovery. It is made perfectly clear that he is not delivering a temperance lecture, but rather alerting his audience to the modern concepts of alcoholism, how one becomes an alcoholic, what help is available, and where to find it. He enumerates the early signs and symptoms of alcoholism, and emphasizes the importance of early recognition and treatment. Part of the lecture period is open for questions and answers.

An observing supervisor is in an excellent position for detecting most early cases of alcoholism. Some cases are extremely difficult to identify, principally the quiet or lone drinkers. However, there are certain signs and symptoms that serve to at least arouse his suspicion, such as: the bleary eyes, the trembling hands, the failure to maintain good personal hygiene and appearance, especially the individual who has heretofore been quite rigid in such matters. Negligence in shaving habits occurs, and his clothing is no longer neat and clean as formerly.

The most useful and positive information can be obtained from a study of the absentee record. Ordinary illness strikes on any day of the week. Absenteeism due to alcoholism most frequently starts on Monday. Thus, frequent absenteeisms which start on Monday are sufficient evidence to warrant careful investigation. A certificate of illness from the employe's attending physician can be misleading. Don't expect a physician to betray his patient by stating "John Doe has been under my care because of excessive drinking." Your plant physician should be able to clarify properly the accuracy of most health certificates.

Supervision need have no imagi-

nary fears of getting into trouble by suggesting, in private conference, that an employe might be drinking too much over the week-end. In all of our years of experience this simple procedure has never resulted in trouble for anyone. It has clarified many problem cases and led to good results.

2. When a supervisor is satisfied that alcohol is a problem, the procedure is as follows: In a confidential interview he informs the employe that the time has come when the company can no longer tolerate his work performance, and unless he takes the necessary steps to overcome his disease, he will be discharged. The employe is put on a probationary period of three months, and immediately sent to the Medical division for further interview and medical supervision during the probationary period.

3. The medical interview is held in strict privacy and the approach is entirely sympathetic, never critical.

Alcoholism is explained as a diseased condition that will lead to total and permanent disability, or even death. Also, that it is a disease which cannot be cured; it can become arrested but the afflicted one can never drink again. If he does, drunkenness will soon be the result, despite any firm resolutions to drink socially and sensibly.

The patient is informed about the help he can get from Alcoholics Anonymous, but never told he must join. Anyone who joins Alcoholics Anonymous must do so of his own free will and desire. Those who are forced to join seldom derive any benefits from the association, and they usually resort to concealed drinking. Each afflicted individual must be impressed with the fact that his cure is entirely dependent upon himself. He must have a sincere desire to stop drinking, otherwise no one can help him. Every patient has it made perfectly clear that he has three months only, and during that time must prove to the satisfaction of Medical that he has recognized the seriousness of his situation and sincerely wants to get well as evidenced by positive action and results. Failure means, beyond a doubt, discharge; and it shall be so written into his personnel record and transmitted to anyone who in the future may be considering him for employment.

4. From Medical he is personally conducted for interview with one of our members of Alcoholics Anonymous. The purpose being to have him hear, first hand, from a person of experience, how sobriety has been attained through the help of Alcoholics Anonymous. He is then required to attend three Alcoholics Anonymous meetings, in order to see and hear firsthand, how many people have been helped and how. This completes our organized efforts to get him started and from then on he is entirely free to pursue whatever course he chooses, provided it leads to total and permanent sobriety.

Except for the very acutely ill, and those on the verge of delirium tremens, all must return to work and remain there for the entire probationary period. No leave is granted. The acutely ill are hospitalized for about two weeks, and are granted leave of absence for this period, provided that they agree to enter a hospital or institution where we know they will be treated by modern and acceptable methods, by those who have learned to understand alcoholism. There are too many hospitals where the alcoholic is still an unwelcome guest, and his treatment, in the main, consists of heavy sedation until the affects of the alcoholic wear off, then discharge, drunk with sedation, and instructions to drink no more or limit himself to beer or wine. Hospitalized patients do not have their medical and Alcoholic Anonymous interviews until they have become sober and are mentally clear. Acutely ill patients are unable to comprehend properly, unable to think clearly, or remember.

Meet the Author

G. H. GEHRMANN is due to retire this fall after 40 years as a physician with the Du Pont organization. Dr. Gehrmann joined Du Pont in 1915, following graduation from Long Island College, where he received his medical training and completed an internship in the college hospital. He saw service during World War I, returned to Du Pont in 1919 and was promoted to medical director in 1926. Last year, he became associate medical director in preparation for retirement in November, 1955.

Plan Most Successful—This plan of procedure is the most successful experienced in the author's 40 years with DuPont. It leads 65 percent of the alcoholics back to sobriety, makes them good employes again, and restores them to health, happiness, and valuable citizens. In most, the home life becomes normal again. Lastly, they become willing and anxious to help others who are in the same plight.

Emotional problems requiring psychiatric treatment exist in some cases, but we never send our patients to the psychiatrist until he has been sober for at least two months. The psychiatrist cannot successfully treat a patient who, because of alcohol, is unable to think and talk with reasonable understanding. Further, many emotional problems become nonexistent with sobriety.

The cost of operating this plan is so nominal that it is hard to estimate. Our own medical staff handles the medical interview as part of their regular duties. The members of Alcoholics Anonymous never charge anyone for the help they give. The patient contributes only his efforts to rehabilitate himself, and continues to perform his daily duties during his period of treatment. Considering the value of a human life, and adding to that the cost of training him to the point of usefulness, we save many thousands of dollars at comparatively infinitesimal cost. Consider also the savings in taxes that must be paid by industry, and all of us, in order to take care of those who go on to permanent disability, and leave, in many instances, dependents who require public support.

After varying periods of sobriety, some patients will begin to play with the idea that with the knowledge they have gained, plus the experience of the past, they can now return to controlled drinking. They start drinking again but soon go out of control. From this experience they become finally convinced that their only hope lies in total abstinence. These episodes are designated as "slips." It is expected that they will occur, from time to time. And it is known that these slips serve further as convincing evidence to the patient that he cannot be a controlled drinker. Allowances are made for two or three short slips, or relapses. —The End

Five Ways To Avoid

A guide to help the supervisor arrive at the best decisions in management problems.

By AUREN URIS, Research Institute of America, New York, N. Y.

AT EVERY TURN, you're beset by the need to decide, to select one course of action from among several: should you contact Mr. Lee or Mr. Bond about the inventory problem? If you contact Mr. Lee, should you acquaint him with the facts of the warehouse damage? If he asks you to give him a complete report on the subject, should you delegate the job to your assistant, or the head of the warehousing operations? And so on.

THE 5 STEPS

Road to better decisions—Here are five steps you can use to help select the alternative with the maximum possibility for success:

1. Spell out your objectives—the results you want.

The more specific you can be, the better off you are. You are in the best position when you can state your goals in number. Knowing, for example, that you must get out "10 units by the end of the day" helps you decide which one of several possible working arrangements to use.

Whenever you can, spell out the quantity, quality, time requirements, that you are after.

2. Examine all possible information sources.

This means availing yourself of all the advice, experience and data you can lay your hands on.

Once you've gotten the raw material, it's up to you to evaluate your facts and data. Considerations like these help:

. . . Test for consistency—for example, verify statements that have been made.

. . . Compare reliability. Particularly where you have two or more views on a single point, it is advisable to weigh one against the other. Past performance can frequently be a dependable guide.

3. Make sure you have considered all possible alternatives.

We all have a tendency to assume that there are no more than two courses of action. Many a decision has failed to pan out because the executive has used the either/or approach. Don't be too quick to make your decision as between "either" and "or". There is frequently a third, fourth, fifth course of action possible.

Use methods like these to develop possible alternatives:

. . . Combination. Can you combine alternatives to gain the benefits of two or more courses of action?

. . . Can your colleagues suggest alternatives that you may have overlooked?

. . . Can anyone of the many elements in the situation—the people involved, the equipment or the materials—help you develop additional possible moves?

4. Weigh the consequences of each alternative.

After you have listed all the possible alternatives, ask yourself, "What will be the consequences of each?"

To help you project the results:

. . . Consult the record to find out what happened in a similar situation previously.

. . . Discuss the possible course of action with people of experience to get their line on possible performance.

. . . Pretest whenever possible. In many situations it's perfectly practical to check the consequences of an alternative by a trial run.

5. Select the best alternative.

To accomplish this step, use as the basis for your selection a re-examination of your goals and your ability to carry out the plan.

You can use these four questions to guide your choice:

1. What are the risks?
2. How much will it cost?
3. What are the time factors?
4. Which alternative comes closest to matching the resources at hand?

There's a visual device that can help you in your consideration of possible alternatives. Just fill in the facts in place of the letters in Figure 1 and your thinking can be fortified.

A tool of this kind helps put the picture down in black and white. But keep in mind that it is a simplification. Obviously, a "Result A" may be brought about by both Alternative X and Y. An actual situation presents a much more criss-crossed picture of the relationship between courses of action and consequences.

And do not feel that once you have arrived at your decision "that's it." It's important for you to implement your decision, of course, but that does not necessarily mean relinquishing control.

As far as possible, make a final check-up before taking action. This "last look" can save many a decision from disaster.

The process of decision-making then doesn't necessarily end when you finally have selected the best alternative. You can retain flexibility by watching developments. It is largely a matter of alerting your people to the results you want and telling them what standards you want used for judging progress.

An Ulcer

No question about the strain this process imposes.

Men in management are under constant pressure to make decisions. You will find few people, high or low, who *enjoy* the process. We all are sufficiently kin to the turtle to develop anxieties about sticking our necks out.

You may have no choice but to enter the valley of decision. You may take the step with head up, chest out, chin in; or, in fear and trembling. One way or the other, the efficiency, even the life of your company, may hang in the balance:

> . . . A competitor hits the market with a new product that's going over like a house afire. Should you try to beat him by a lower price, or remove the wraps perhaps prematurely from a model your development people have been working on?
>
> . . . Your superior has asked you to dig into the reasons for a fouled-up situation in one of the production units. You know the fault is mismanagement by X, a colleague and friend. Can you do justice to the assignment without doing a hatchet job on X? Or, should you even try to save X's hide, on the theory that he's got it coming?

Every area of your executive activity, from technical matters to normal relationships involves decision-making. That's why one well-known medical authority on getting his first taste of business life in the role of medical advisor to a big corporation states: "I don't understand how any of them (executives) can avoid them (ulcers).

Making decisions would be much less of an ordeal if you could be assured that the decisions you make would not kick back. Obviously, it is the fear of failure, the consequences of guessing wrong, that makes the process an ordeal.

Decision-making may be a major or minor strain for you. Even if you're lucky, and put yourself in the minor category, the emotional ordeal can be further diminished if you (a) have a better understanding of what a decision is; (b) learn how to failure-proof decisions.

"I don't understand how any of them (executives) can avoid them (ulcers)."

Elements of decision-making—To begin with, there's one fact that's often overlooked. There are two elements involved in decision-making:

- **Decisiveness.** This is the manner, or the feeling, that surrounds the process of decision-making.
- **Selection of an alternative.** This is the mental act by which you finally select one out of two or more possible alternatives.

An interesting question arises at this point. Is it *necessary* to be decisive in order to make sound decisions? The answer is obviously No, once you stop to think about it.

Still, your emotional attitude *is* a factor in the wear and tear that decisions represent. And, it is likely that the decision that grows from a relaxed frame of mind is apt to be sounder.

Unfortunately, the problem of changing your emotional reactions to decisions can't be directly tackled short of the psychiatrist's couch. But there is one saving thought. If you can failure-proof your decisions, if, for example, you can increase your skill in the *second* aspect of decision-making, selection of an alternative, chances are very good that your attitude—your self-confidence—will also take a turn for the better.

Choosing alternatives—No system can ever lead you inevitably to a correct decision; you will always face unknown or unanticipated elements. You decide, for example, after considerable thought, that Subordinate A is the best man to be trained to be your assistant. He is enthusiastic, and everything goes along swimmingly for six months. Then his diamond-mine-owning uncle in South Africa kicks the bucket and leaves him $5 million. Needless to say, your six months of training goes out the door, along with the assistant.

There was nothing wrong with your decision. Unfortunately, later developments proved it to be "wrong." You can never anticipate all eventualities. That's why you will always find someone willing to take the odds at the track. But within the limits of reason, it's possible to improve your decision-making score.

Decide or defer?—Sometimes, of course, you have to choose between making a decision or deferring a decision.

During World War II, dozens of ships, hundreds of lives were lost when a large American task force was caught in a typhoon in the western Pacific. One explanation was a failure to make a decision that would have substituted corrective action for standing orders. You would have to accept that statement in the light of other facts: weather information that was neither timely nor accurate; commanding officers on the smaller vessels reluctant to report worsening conditions.

There can be no doubt that, in some situations, the executive who puts off making a decision is courting disaster. But there is another side of the question of "decide or defer."

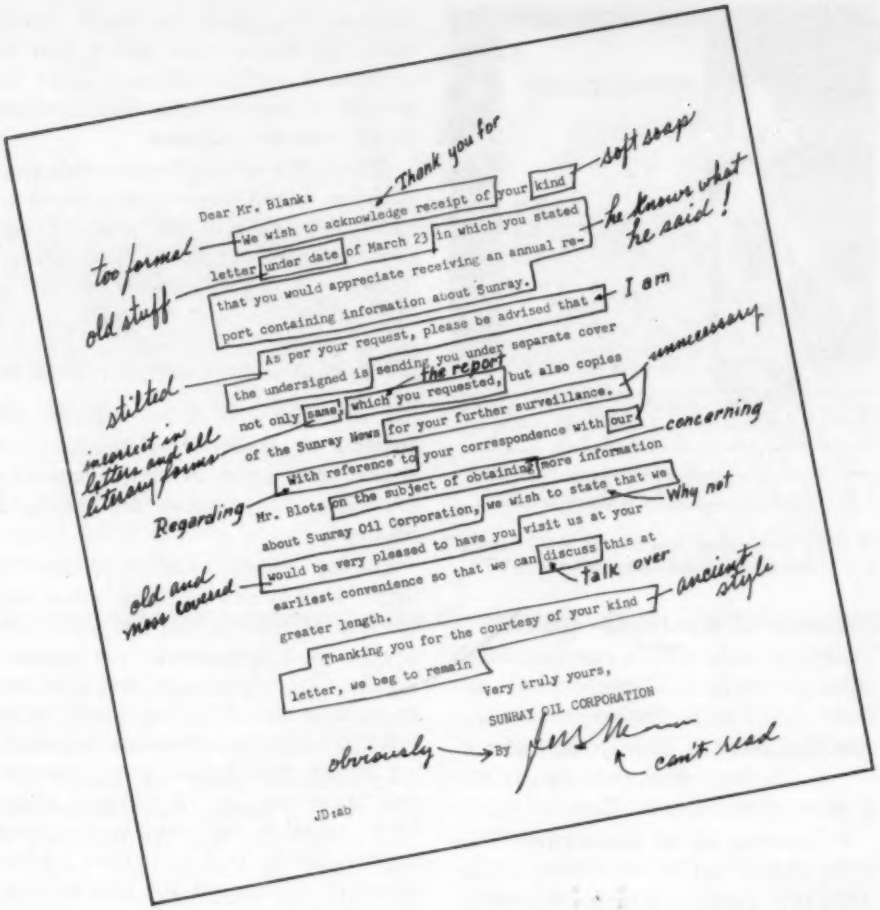
One word in the English language that has put more pressure in more executives than any big boss in the business.

The word is *procrastination*. But there's a lot to be said in favor of procrastination. There are a number of occasions when it is wise to hold off making a decision:

> . . . when, for example, the delay gives you more time to gather facts that help you develop and evaluate alternatives;
>
> . . . when the time you gain can help you do a better job of consultation and checking;
>
> . . . when there is no actual time-pressure on you, and nothing to be gained by an early decision.

Whether you decide to do the more immediate job or to postpone it in favor of more remote considerations, your question is always the same: What decision, compromise or otherwise, will serve ultimate objectives best?

—The End


Dear Mr. Blank:
Thank you for
We wish to acknowledge receipt of your kind
soft soap
too formal
letter under date of March 23 in which you stated
he knows what he said!
old stuff
that you would appreciate receiving an annual re-
port containing information about Sunray.
I am
stilted
As per your request, please be advised that
the undersigned is sending you under separate cover
the report
incorrect in letter and all literary forms
not only same, which you requested, but also copies
unnecessary
of the Sunray News for your further surveillance.
concerning
Regarding
With reference to your correspondence with our
Mr. Blotz on the subject of obtaining more information
about Sunray Oil Corporation, we wish to state that we
Why not
would be very pleased to have you visit us at your
old and most covered
earliest convenience so that we can discuss this at
talk over
greater length.
ancient style
Thanking you for the courtesy of your kind
letter, we beg to remain
Very truly yours,
SUNRAY OIL CORPORATION
obviously
By
can't read
JD:ab

From *Sunray News*

How to Write Good Letters

Be brief. Be clear. Be yourself and write like you talk. A good business letter can be a powerful instrument.

WRITING GOOD LETTERS is as simple as being yourself! Because a good letter is natural, brief and friendly. A good business letter gets things done!

Whether you are dictating or writing the letter yourself, take a few minutes to plan what you want to say. Write like you talk. If you want to visualize your reader, his letter will give you some clues. To be sure that you cover all important points in your answer, try underscoring his letter. Then cover the points one at a time.

Most of the letter-writing "don'ts" in studies on the subject tell us in effect to throw away our mustache cups and get modern.

Avoid beat-up, worn-out and white-whiskered phrases handed down from the past.

It is possible to take a needle of information and bury it so deep in a haystack of words that digging any sense out of it is a real job, if not downright impossible.

Take, for example, beauties which begin like:

"Regarding your communication of recent date, please be advised that we conducted an investigation throughout our records and wish to call your attention to the fact that . . ."

Why not:

"Thanks for your letter of October 1. Our files show . . ."

To be a real blow-hard, toss off something like:

"This communication is for the purpose of requesting that you give consideration to adding my name to your list of those who receive your monthly bulletins. For your information, this would be of tremendous assistance to personnel in this department whose assignment it is to produce similar bulletins on related subjects at frequent intervals. Thanking you in advance for this favor, and assuring you of our prompt attention if at any time in the future we can return this most kind courtesy, I beg to remain . . ."

Instead, write something like:

"Could you put me on your list to get your monthly bulletins? It would be appreciated."

When you discard these hackneyed phrases you will find your letters are easier to read, more clear and concise.

Since a company's correspondence is an important public relations agent, its reputation rides on every letter you write. If it is written in an antiquated style it suggests to the reader that the company itself is behind the times.

It's all as simple as this—

Do:

1. Answer promptly
2. Get the facts straight
3. Be clear, concise, courteous
4. Be specific
5. Create a good impression
6. Be natural; just "talk"

Don't:

1. Beat around the bush
2. Use obsolete phrases
3. Overdo apologies
4. Write without thinking
5. Sign a poor letter. Do it over!
6. Fail to make it human

Before you sign the letter, scan it to see that it is friendly in tone. See that it answers all questions in logical order. Make sure it is easy to understand and stop and think how you would react if you were the reader. Get the letter off promptly. Then pat yourself on the back. Remember, your company's reputation—and yours too — rides on every letter that leaves the offices.

—The End

WASHDAY

at El Paso Natural . . .

Saved $48,000 on just one gas transmission line through detergent cleaning that restored efficiencies up to that of new pipe. Cleaning took 8-12 hours downtime.

By CLINTON McCLURE, El Paso Natural Gas Company, El Paso

El Paso Natural Gas Company saved $48,000 in just one instance by cleaning a pipe line with detergent and water. The line involved handled before cleaning 281 million cubic feet per day requiring 11,000 horsepower upstream and 51 hp downstream. Each station used about 2100 hp less after pigging, while handling 330 mmcfd or 17 percent more gas.

In 1948, El Paso Natural tried the pipe line construction method of pigging lines that had been in service for some time. This process consisted of blowing down the line, cutting into it and running a steel-wire pig without using a washing agent. Results depended upon flow efficiency before cleaning. Lines with efficiencies 40 percent below maximum were improved 5 percent. Those with higher efficiencies were increased from 1 to 5 percent per pig run. However, downtime and labor expense for more than two pig runs proved this method to be uneconomical.

Lines contained lubricating oil, water, iron sulfide, dirt, treating plant fluid, and steel shavings. These materials formed a sticky, high viscosity mixture that adhered to the pipe wall. Addition of small amounts of water

FIGURE 1—Operation Washday finds these men mixing detergent and water (75 pounds per 1000 gallons) in a funnel and feeding it into the line just downstream from the control joint. Detergent used is type 7.0 to 9.6 pH, such as that used in many cafeterias.

FIGURE 2—The blow joint has just been blown free of the pipe, following entry of the cleaning pig. Detergent solution is washing out large quantities of dirt and oil from the section being cleaned. Thorough cleaning requires 500 feet of water wall contact.

ahead of the pig proved more effective in removing this coating than the dry-run pigs. However, an oil film surrounded the materials, and water alone would not remove those materials that were not water soluble.

In search of a better cleaning method, El Paso Natural began using a detergent-water mixture in 1949. A sample of pipe to be cleaned was brought into the water laboratory and several types of detergent-water solutions were tested to determine the most effective. A 7.0 to 9.6 pH detergent, such as that used in many cafeterias, cleaned these gas lines best.

Water analysis at sources where pipe was to be cleaned, governed the amount of detergent needed. Detergent was added until a slight agitation made rich suds. Lack of suds at the discharge end of the section usually meant more oil was present than was anticipated. Additional detergent was then run to correct the situation and correct amount of detergents were used in the first run of other sections in this area.

Field improvements in technique depend upon procedures, the cleaning instruments and equipment.

Here is the equipment used in detergent cleaning of gas pipe lines:

1. Pig control joint with couplings.
2. Blow joint assembly.
3. Water storage tanks (remote sections).
4. Pump of sufficient size to pump in water in 30 minutes.
5. Hose or pipe for pump and storage tanks.
6. Excavating equipment for bell holes.
7. A minimum of two welding machines with cutting torches.
8. Large mixing funnel or mixing tank.
9. One joint of pipe (for restoring pipe line).
10. Four line-up clamps.
11. Two pipe lifting machines (minimum).
12. Trucks to haul equipment and supplies.
13. Two beveling machines.
14. One pressure recorder (0-50 psi or 0-100 psi).
15. Three 4 cups swabs or equivalent.
16. Three wear compensating pigs or equivalent.
17. One exploratory pig if line has never been pigged. This should be of same type and length as those used with detergent and rinse.

All pigging equipment is carried to the site and prepared before blowdown begins. Pigs and swabs are inserted in the control joint prior to the blowdown. Water and detergent are the only materials needed.

Preparation of site. First bell holes are dug at each end of the section to be cleaned. The control joint is located at the best natural sag in terrain. This sag prevents water from running too far down the line before the pigs catch it.

Soil is stripped back from the pipe far enough to get "slack" or longitudinal compression back into the pipe line after the cut. This makes for an easier line-up when re-welding. Storage tanks should be set as close as possible to the pig control joint to reduce pipe or hose friction to the minimum.

An extra joint of pipe is placed at one end to be used after the cleaning operation is finished. The joint removed here is cut slightly longer than that needed for the other end so only one joint is needed from stock. The joint removed can be salvaged during the pigging operation.

When blowdown is complete the first cut is made at the high end. Cuts need not be over five diameters apart to fit the blow joint. Cuts at the control joint end are only about one inch longer than the control joint. After line cuts are completed, the blow joint is welded on and the control joint is coupled in.

Next the pressure recorder is connected to the control joint at the point nearest the exploratory pig. This instrument records the actual pressure admitted. A 0-100 psi recorder is used on pigs up to 16 feet and a 0-50 psi recorder is used on larger sizes.

After connections are made, pressure is admitted to the exploratory pig via the bypass on the control joint as shown in Figure 3. The speed of the exploratory pig is not too important except in cases of possible line rupture at bends or obstructions. Blow-joint should be used to preserve the exploratory pig.

Following the exploratory pig run the operator opens the water hole valve on the control joint. Water is admitted by gravity through the funnel as shown in Figure 1. Detergent is shoveled into the funnel and mixed with the first 200 gallons of water. El Paso Natural engineers have found that 75 pounds of detergent per 1000 gallons of water is a good ratio. After the required amount of detergent has been mixed with the water, the funnel is removed and the pump discharge is connected to the water injection valve.

Thorough cleaning requires 500 feet of water wall contact. More detergent solution improves cleaning if there is one swab cup for each 50 feet of water wall contact. This count includes only those cups on the swabs. To determine the volume of water required for 500 feet of water wall contact use the formula:

Gallons = 20.4 $\times$ inside diameter of pipe in inches squared, thus for 24-inch pipe, volume required would be: $(20.4)\ (24)^2 = 20.4 \times 576 =$ 11,750 gallons per 500 feet.

Upon completion of filling and insertion of the spare blow joint, the section is ready for the detergent-water run. A listening post is established at a point near the first one-third of total travel. To start the wash operation the front retaining pin on the control joint is pulled and pressure is admitted behind the pig. The pressure is read when the pig moves out and 10 percent is added for the propelling pressure. An 8 to 12-mile-per-hour pig speed is desirable. The one-third point arrival time determines the amount of pressure necessary to be added or taken off. Frequent changing of propelling pressure is not desirable. Progress of the pigs cannot be determined if this occurs. The cleaning foreman must bear in mind that considerable time and expense already have been put into this operation and attempting to decrease the downtime by fast pig runs will only jeopardize the results of a cleaning job. Only about one-third of the total time out of service can be charged to pig runs where no more than ten miles are cleaned in one operation.

The pig and swab actions cause suds and water discharge to come in surges. An observation of heavy surges should convince an observer of the effectiveness of this type of cleaning. The first portion of the discharge mixture generally appears cleaner. As the pigs approach the blow joint the mixture darkens. When the pigs enter the blow joint, it is blown off and the entire open end of the pipe bleeds off the pressure as shown in Figure 2.

Following the detergent wash, an equal amount of clean water is pumped in ahead of the rinse pig and swabs at the control joint. The second retaining pin is removed and pressure is again admitted. In most cases where there are medium heavy pipe line deposits, the pressure required to propel the rinse instruments is greater than that in the detergent run. There are two reasons for it—there are more cups in action on the swabs; also, the detergent has penetrated into the deposits and loosened them so the rinse run carries them out.

Again speed regulation is attained by timing at the one-third point and correcting. Pig speed in this run is also 8 to 12 miles per hour. The discharge mixtures of the rinse run contain more of the pipe line deposits.

After rinse instruments are discharged and blowdown is complete, the blow-joint assembly and control joint are removed. The line is then prepared for service. The total cleaning operation requires 8 to 12 hours downtime.

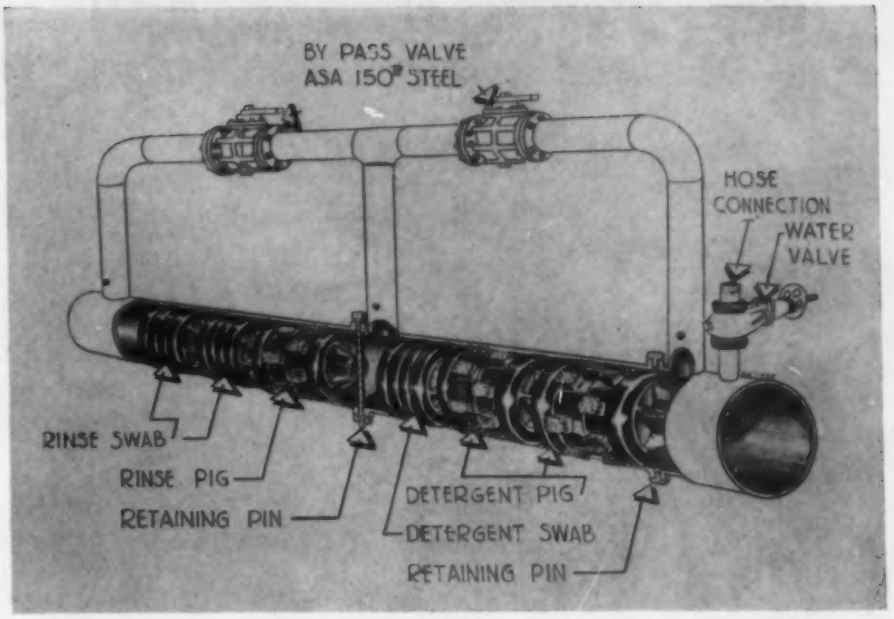


FIGURE 3
Control joint is used to launch pigs into section of line being cleaned with detergent-water solution.

Disposal of water when using the detergent method may become a real problem in farm area or grasslands. Damages may be reduced by ditching out of the area or by digging a large pit. Actually the manner of removing pipe line deposits has little to do with the damages necessary to be paid. The water-detergent deposit mixture is as easy to control as the dust discharged using the dry method. In addition, the risk of fire is much less with the detergent water method.

Operating Limitations

1. Pig run should not exceed ten miles. If more than a ten-mile run is necessary, increase amounts of water and detergent proportionally. This has been tried but results were not as good as those obtained for ten-mile runs.

2. The pH of the detergent (7.0 to 9.6) is not the only requirement for its application. It must contain an abundance of wetting agents, too.

3. Check valves installed in the swabs must not require more pressure to open than is required to propel the pig.

Higher efficiencies. The average cost per mile for cleaning various size pipe is predicted:

30" O.D.	$346/mile
26" O.D.	$325/mile
16" O.D.	$282/mile
6⅝" O.D.	$250/mile

These figures do not include the cost of gas for blowdown or downtime charges. Water haul distance has varied from 5 miles to 30 miles. The hauling distance is a large factor in the cost of cleaning by this method.

The resulting efficiencies from cleaning 16 sections by this method from 1950 to 1954 were:

Pipe O.D., Inches	Section Length in Miles	Efficiency Before	Efficiency After	Efficiency Increase
8⅝	7.91	76.6	86.5	9.9
8⅝	7.99	75.1	87.1	12.0
8⅝	8.33	80.4	90.3	9.9
8⅝	7.85	73.2	82.6	9.4
16	9.47	82.2	89.8	7.6
16	7.48	84.9	91.5	6.6
16	9.47	80.4	86.1	5.7
16	7.48	73.0	82.2	9.2
16	10.13	72.2	87.5	15.3
16	9.53	72.7	86.5	13.8
26	8.022	85.6	91.4	5.8
26	7.876	75.4	86.2	10.8
26	8.106	80.1	87.5	7.4
26	9.095	77.7	84.1	6.4
26	9.15	69.8	84.4	14.6
26	8.68	67.2	83.7	16.5
Average	....	76.6	86.7	10.1

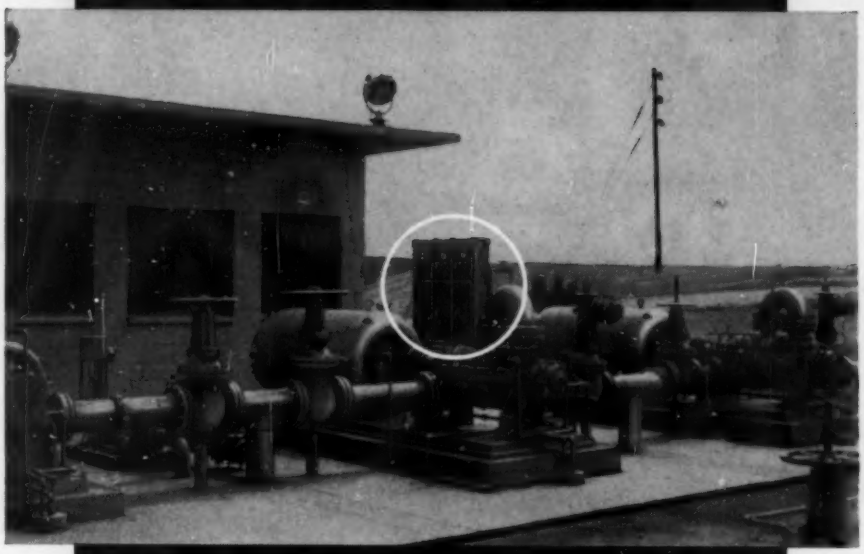
During 1954 El Paso Natural cleaned six adjacent sections of 26-inch O.D. line with the following results:

Pipe O.D., Inches	Section Length in Miles	Efficiency Before Percent	Efficiency* After Percent	Efficiency Increase Percent
26	8.070	64.8	86.4	21.6
26	9.152	60.9	91.4	30.5
26	8.681	53.9	84.2	30.3
26	8.795	81.1	89.4	8.3
26	8.580	84.2	92.6	8.4
26	8.604	81.3	90.8	9.5
26 (over-all)	51.882	67.5	90.3	22.8

* New Pipe Efficiency = 92 percent.

The main reason for the higher

EC&M 2200-5000 VOLT



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❸ Dependable, low-cost operation

In tank farm, gathering station, and pipeline pumping station applications, EC&M high voltage motor starters have earned a reputation for dependable, low-cost operation.

EC&M starters are virtually trouble-free, oil-immersion keeps working parts well lubricated . . . protects against corrosion. And, being automatic push button type, these starters make it easy for a station attendant to start or stop the motor-driven pumps as required.

In prominent oil centers, EC&M 2200-5000 volt motor starters are recognized for their efficiency and long life.

Investigate them today!

Write for Booklet 1062

THE ELECTRIC CONTROLLER & MFG. CO.

4498 Lee Road, Cleveland 28, Ohio

6079

efficiencies obtained in 1954 is attributed to the vented swabs with check valve. Better agitation of the detergent and water provided more thorough cleaning.

Effect on operation. The 1954 pigging data show the value. Actual operating horsepower was obtained before and after the pigging:

Horsepower used at upstream end before pigging to pump 281 MM cfd	11,000
Horsepower used at downstream end before pigging to pump 281 MM cfd	5,100
Horsepower used at upstream end after pigging to pump 330 MM cfd	8,900
Horsepower used at downstream end after pigging to pump 330 MM cfd	2,900
Difference in hp at upstream end.	2,100
Operating cost per year at upstream end (additional) at $20.60/hp	$43,260
Difference in hp at downstream end	2,200
Operating cost per year at downstream end (additional) at $15.00/hp	$33,000
Total operating cost for hp	$76,260
Total pigging cost	$28,000
Difference	$48,260

In addition to the hp savings, 49 MM cfd of additional gas was transmitted.

Any method of blowdown cleaning is expensive. If the line has to be cleaned, the quickest and most effective method should be used. The detergent-water method produces very good results with a minimum downtime.

ACKNOWLEDGMENT

This article is a condensation of a paper presented by Clinton McClure, El Paso Natural Gas Company, at the Gas Supply, Transmission, and Storage Conference of the Operating Section, American Gas Association, Pittsburgh, Penn., May 9-10, 1955.

—The End

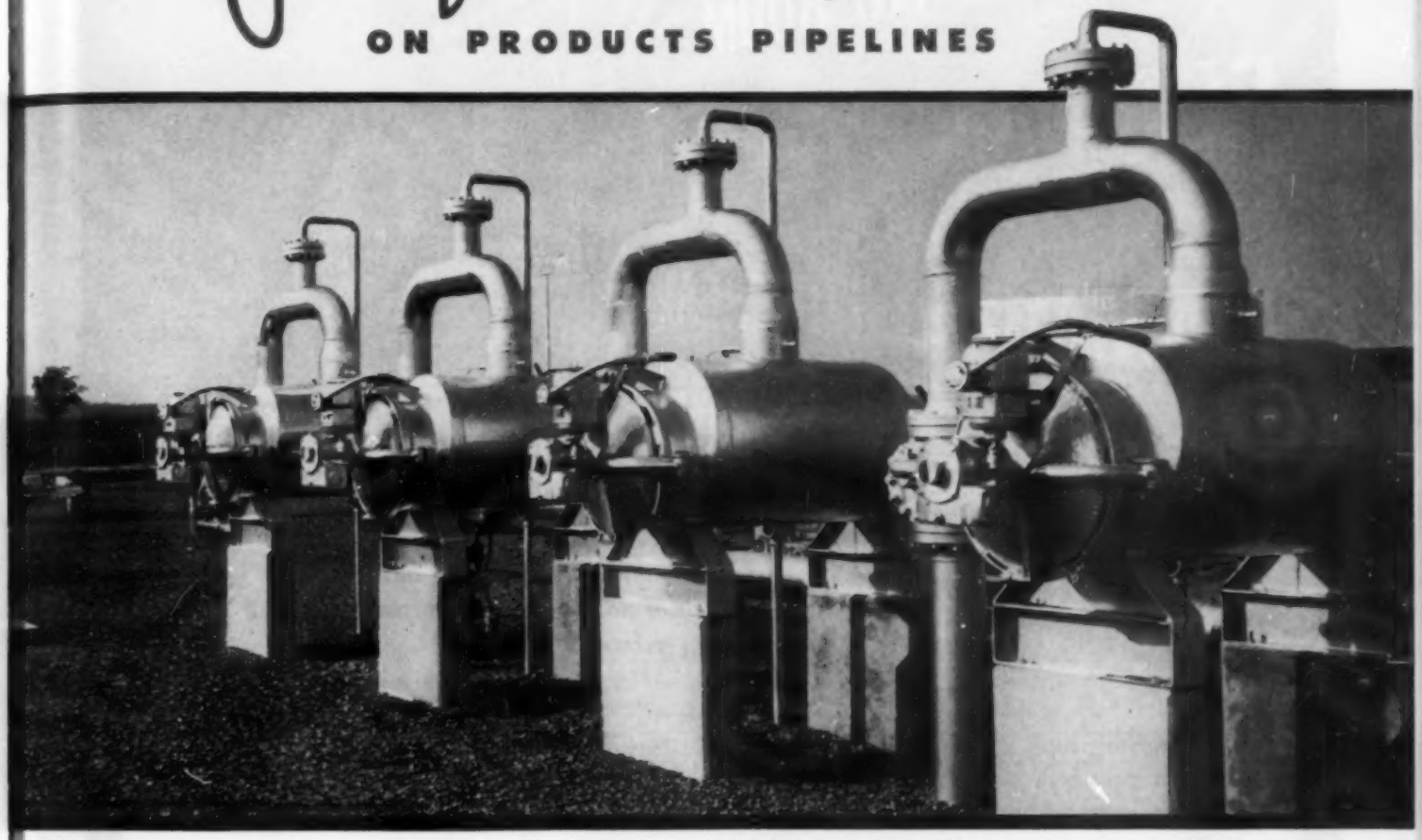
Saskatchewan Power Begins Construction of Gas Line

Work will begin early this month on the Saskatchewan Power Corporation line from Coleville to Prince Albert, Sask. A 116-mile 14-inch line will be built from Coleville to Saskatoon. The Saskatoon-Prince Albert section will be made up of 40 miles of 12-inch and about 70 miles of 10-inch.

Majestic Contractors Ltd. and Banister Construction Ltd. are the contractors on the job. The line is scheduled for completion by October.

Good filtering is good business

ON PRODUCTS PIPELINES



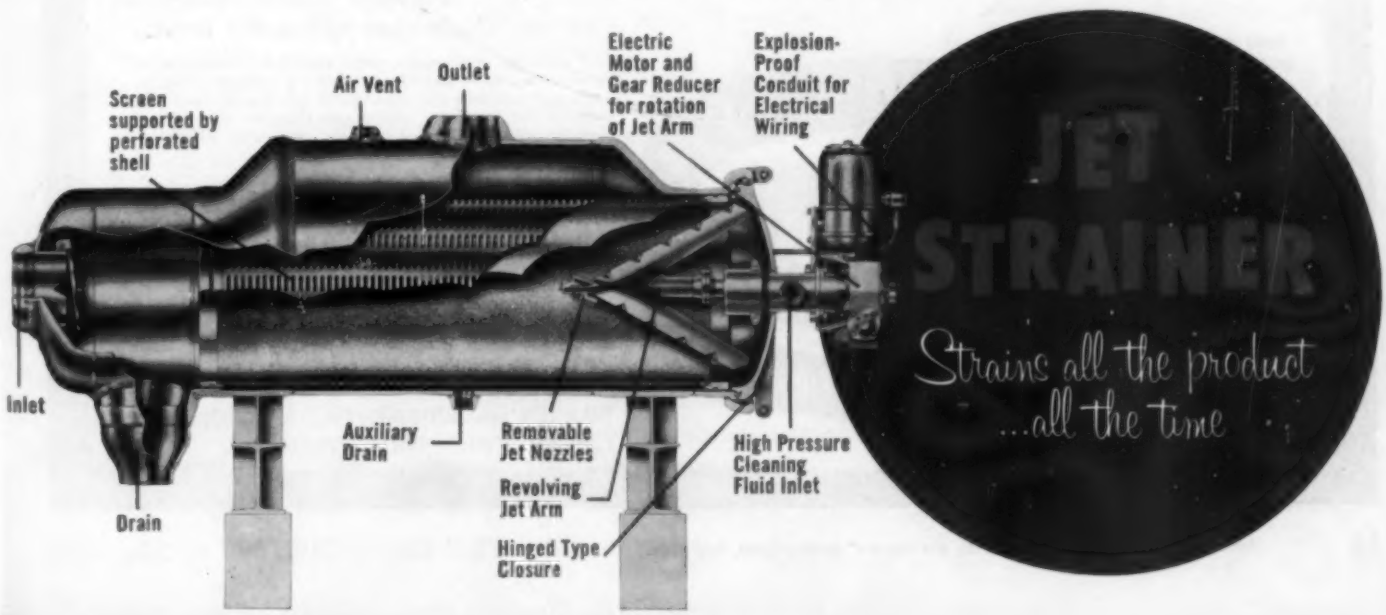
Only those strainers that filter *all* of the product . . . *all the time* . . . can protect pumping and metering equipment against wear, and control sediment in products. It is difficult to justify the cost of strainers that blind readily when the stream is loaded with solids and water and which cannot be cleaned rapidly enough to avoid bypassing or shutting down the pipeline.

Jet Type Strainers may be cleaned and returned to service in from 3 to 5 minutes by simply pressing a button on a control panel. Usually, a single operator can manage the entire strainer installation, or the *Jet Strainers may be made fully automatic if desired.* Consequently, Jet Strainers can be depended upon to "strain all the product . . . all the time." No bypassing, intentional or accidental. No slowing down or stopping the line to permit cleaning of strainers.

Per square foot of screen area, Jet Strainers cost little, if any, more than ordinary sock strainers. And the protection they provide for the entire pipeline system, plus low maintenance, are continuing extra benefits.

THORNHILL CRAVER CO.

P. O. BOX 1184 HOUSTON, TEXAS



THERE'S NO ROOM FOR VAPOR TO FORM IN A HAMMOND TUBESEAL FLOATING ROOF TANK

The Hammond Tubeseal Floating Roof is different from all other floating roofs because its design and construction does not provide space where air-vapor mixtures can form.

All floating roofs now in general use, except the *Hammond Tubeseal*, provide a space between the shell of the tank and the outer rim of the roof where air-vapor mixtures form.

If a sour crude is stored in a conventional floating roof tank, excessive corrosion of the tank shell and rim plates will occur where air-vapor mixtures form. Unless the metal shoes and flexible fabric covers provide an absolutely gas-tight housing, some of the vapor will be lost. If the stored product is of intermediate volatility such as jet fuel (JP-4 grade) combustible vapors will exist in this space under all normal atmospheric temperature ranges. Any ignition as from lightning will cause violent combustion.

The Hammond Tubeseal eliminates this space and prevents the forming of any air-vapor mixture. Corrosion is stopped even for sour crudes. Jet fuels such as JP-4 grade may be stored with assured safety from rim fires. *Vapors which cannot form cannot ignite or be lost.* There is no room where vapor can form in a Hammond Iron Works Tubeseal Floating Roof.

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CHEAPER OVER THE YEARS

HAMMOND IRON WORKS
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Coal Pipe Lines . . . A More Competitive Price With Oil And Gas Fuels?

- A giant 108-mile coal pipe line is nearing completion.
- Engineer-scientists have licked their greatest problem—internal erosion of the pipe.
- Coal pipe lines can mean cheaper electric power.

By **DONALD M. TAYLOR,** Editor, PIPE LINE INDUSTRY

THE WORLD'S FIRST major coal-hauling pipe line is scheduled to be completed late this year. It will be 108 miles long, running from the Georgetown, Ohio, coal mines to a power generating plant near Cleveland.

Manned by centrifugal pumps similar to those found in crude oil pump stations, the line will handle a slurry of half water and half finely ground coal. Its design capacity is rated at 1.2 million tons of coal per year.

The immediate engineering which must precede construction is being done by Ford, Bacon and Davis. But the fundamental engineering which makes the venture possible was done in the research laboratory of Pittsburgh Consolidation Coal Company, the world's largest coal producer.

The company's engineer-scientists quietly evolved techniques which they feel have licked the most difficult single obstacle to coal pipelining—internal erosion of the pipe. They also satisfied themselves that the danger of the coal falling out of the carrying water and "freezing" the line during an unexpected shutdown was negligible if proper design is followed.

Coal pipe lines have been built before. In 1913 a 2000-foot line was built in London to discharge coal barges from the Thames river. It operated with less than moderate success for ten years. Other lines are in service today. One is a 5-mile, 15-inch line in France which transports fine coal and water from a coal preparation plant to a power plant.

The only trouble with present day lines is that the coal erodes the bottom of the pipe (Pittsburgh Consolidation scientists have labeled it "corrosion-erosion.") To get even reasonable life out of lines in the past, the pipe had to be constantly rotated so the wear would be distributed evenly around the circumference.

This is why construction of a major coal-hauling pipe line was not feasible until recently. But the Pitt Con scientists are not divulging information regarding their technique for overcoming this corrosion-erosion. For one thing patents are involved.

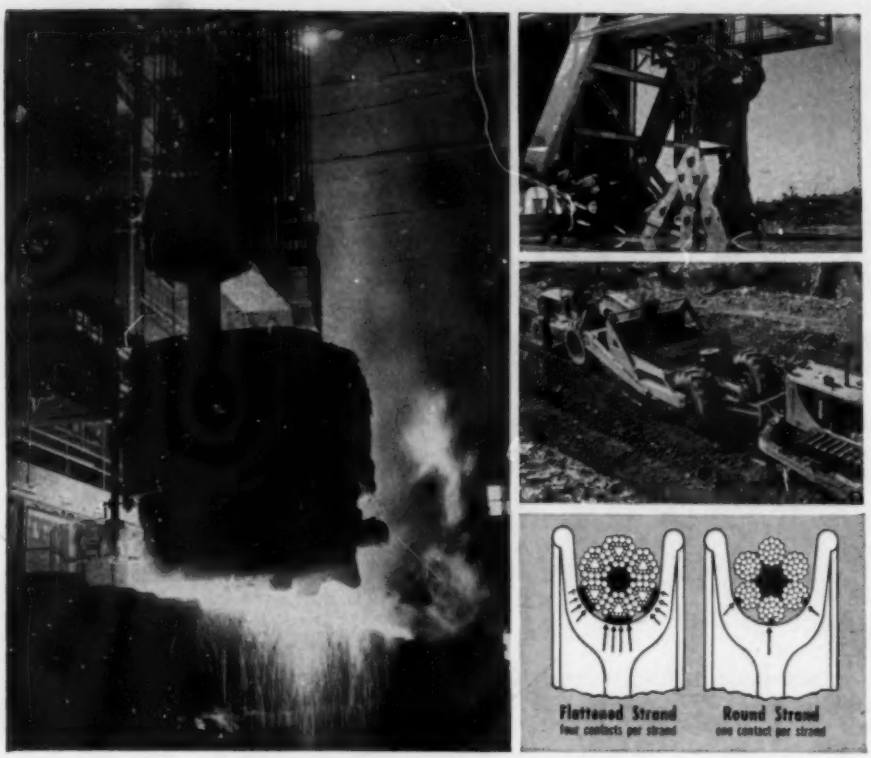
If the promise of the new designs are fulfilled, it could have a terrific impact on the energy-supplying industries. Reduced transportation costs could make coal more competitive with oil and gas fuels. It could mean cheaper electric power.

The original announcement of the proposed line came out about a year ago. It made rail officials take notice and conjectures on rate structures flew thick and fast. The freight rate for coal between Pittsburgh Consolidation's eastern Ohio mining properties and Cleveland Electric Illuminating Company's Eastlake power generating plant, the ultimate destination of the coal, was about $3 per ton. When the line was announced, it was reported in New York that railroads contemplated reducing the freight to $1.60 per ton, hoping to forestall construction of the line.

But this would have upset the entire coal rate structure of the area, and the bosses of the three railroads most affected by the line gave up the idea of whipping 'em or appeasing 'em in favor of joining 'em.

The two railroads now serving the Georgetown mines, New York Central and The Nickle Plate (New York, Chicago and St. Louis), and the Pennsylvania upon whose line the utility plant is located have extended the glad but somewhat limpid hand of "cooperation" in exchange for the right to buy a substantial piece of the line anytime during the next ten years.

The pipe line will cross beneath the rail lines at 11 points and this valuable option will offset possible court suits, even though the pipe line has the right of eminent domain.



How to handle the tough jobs with Hercules Flattened Strand wire rope

When you think you need a super-rope, check Hercules Flattened Strand. This is the wire rope that packs in 10% more steel than round strand rope, making it 10% stronger and safer. It wears longer and more evenly—reduces sheave wear, too.

The 10% extra strength over round strand rope is sometimes the difference between the possible and the impossible. Hercules Flattened Strand frequently does the tough jobs which would otherwise require larger size rope—and without the bother and expense of changing sheaves and drums. The extra strength is useful, too, when shock loading is involved. Saves rope—and money.

If you think that Hercules Flattened Strand wire rope may solve a problem, talk it over first with your Leschen man. He can be reached through your nearby Leschen distributor. His advice is based on the best possible authority—Leschen's long experience and engineering research—the longest in the industry. And with Leschen wire rope you are assured of higher-than-rated quality and longer-than-expected service.

If you can use Hercules Flattened Strand rope you'll be money ahead. See about it soon.

Depend on Leschen's higher-than-rated quality for longer-than-expected service.

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HERCULES *Red-Strand*® WIRE ROPE
LESCHEN WIRE ROPE DIVISION
H. K. PORTER COMPANY, INC.
St. Louis 12, Missouri
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Gulf Interstate to Build "Satellite" Station

An experimental unattended "satellite" compressor station will be built near Stanton, Ky., by Gulf Interstate Gas Company following recent FPC approval.

The station will be controlled by operating personnel from the Clementsville, Ky., station, 80 miles away. Plans call for operation of the experimental station on a standby basis for a 15-month test period. During this time the economics and feasibility of non-attended operation will be studied, say company officials.

A 3500 horsepower, four-cycle, turbo-charged, vertical gas engine will drive a centrifugal compressor through a speed increaser. This unit will be the first of its type in service on a gas transmission line.

If the experiment proves successful Gulf Interstate will request further authorization to maintain the unit on its 30-inch line prior to termination of test. If it is not successful, $450,000 of the estimated $730,000 original cost could be salvaged.

Pan American Changes Name to American Oil Pipe Line Co.

The name of Pan American Pipe Line Company has been changed to American Oil Pipe Line Company. Headquarters for the company are in Houston. There will be no changes in officers or management, according to President Ira O. Walker.

Rubber Ball Squeegee Promises Improved Batch Separation

Early tests of a new squeegee, a rubber ball with a liquid filled center, give its developers high hopes for future applications in operating lines.

Natural rubber is formed into a hollow ball with a wall thickness of 3 to 6 inches depending upon the diameter. A ball is slightly larger than the inside pipe diameter, even before the center is filled and pressured. The liquid pressured center gives the ball added physical strength and controlled resiliency. An ordinary tire valve permits filling and pressuring the ball. Spheres are normally inflated to about 40 pounds per square inch. Natural rubber has been used in the experimental balls, however, neoprene or synthetic materials may be used.

The inflated rubber ball is run like

For more data on advertised products, use Readers' Service Cards, last page.

From meter stations to offices

Armco Steel Buildings meet every pipe line need

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Warehouse

Meter Station

Versatile is the word for Armco Steel Buildings in the oil and gas industry. They are widely used for pumping and compressor stations, communications buildings, meter stations, offices, warehouses, maintenance shops, and other structures. Armco Buildings are functional, efficient and economical—yet they offer quality and neat appearance.

When you select an Armco Steel Building you get a packaged structure—adequately designed and engineered. The Armco STEELOX Panel provides both structural strength and smooth exterior in a single unit. Heavy gage all-steel construction assures durability and fire-resistance.

EASY ERECTION

Fast erection of Armco Steel Buildings requires no previous experience. Extending structures is easy with standard parts, and the building may be completely dismantled and re-erected on a new site without loss of material.

Armco has been manufacturing steel buildings for more than a quarter of a century. Thousands are in use today, all over the country. No matter where you are located there is an Armco Plant and sales office near you for easy ordering and fast delivery. Write us for data on your specific building requirements. Armco Drainage & Metal Products, Inc., 3745 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. Export: The Armco International Corporation.

Armco Steel Buildings

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Why
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prefer and buy the genuine
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PIPE WRENCH?

It's easiest to work with... perfect balance . . . comfort-grip I-beam handle . . . handy pipe scale on hookjaw . . . easy-spinning adjusting nut . . . clean grip on pipe, no slip or lock.

It lasts longer... first guaranteed housing, won't break or bind . . . ever. Every wrench individually tested before shipment . . . and millions of them in use. Sizes 6" to 60"—end pattern, 6" to 36".

For the most for your money, buy RIDGID . . . Your local Supply House stocks them for you, delivers them fast!

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

RIDGID
Work-Saver Pipe Tools

an ordinary squeegee. When pressure is built up behind the ball, it takes a shape resembling a short bullet—streamlined on the forward end and somewhat flattened at the rear. Score marks on the side wall of the rubber sphere are straight and parallel, giving evidence that travel through the line is without spin or rotation.

The rubber spheres were first tested in the calibration of meters on products lines. Results were good enough to lead to more experiments with batch separation. Engineers who developed the ball are not making great claims, but further operating tests are under way. If results are as good as in earlier tests, what of future applications?

Here are some likely advantages over present methods:

- Better wall contact over irregular pipe surfaces
- Greater flexibility of squeegee, permiting passage through valves and line restrictions
- Reduced bypass of fluids giving more complete separation of product batches and more accurate meter calibration.
- Faster and more thorough drying of pipe lines following hydrostatic testing.

Tougher Merger Stand Seen; FTC Report Is Noncommittal

To shed more light on the practice of business mergers, the Federal Trade Commission recently issued a 233-page report based on its own research, but avoided saying flatly whether the current wave of mergers is good or bad.

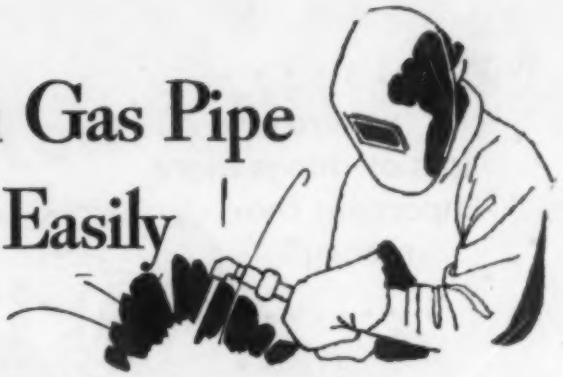
From this study, the Commission will decide if, and to what extent legislative recommendations are desirable. The next step may be a tougher stand by the government on corporate amalgamations and acquisitions.

In attempting to set forth some guideposts to apply to Sec. 7 of the Clayton Act and the 1950 amendment which further restricted merger activity, the FTC study first listed the mergers from 1948 through mid-1954 and then attempted to analyze the reasons behind those mergers.

The study found 387 reported mergers in 1954, which was three times as many as in 1949. Nearly two-thirds of the acquisitions from 1948 through mid-1954 were made by companies with assets of $10 million or more. Firms with assets of less

For more data on advertised products, use Readers' Service Cards, last page.

Bethlehem High-Strength Gas Pipe Resists Fatigue—Welds Easily



Bethlehem High-Strength Gas Pipe is recommended for pipe-line compressor stations and other locations where severe vibrations or extremely high pressures are encountered.

This pipe is fabricated from as-rolled plates of Mayari R, Bethlehem's high-strength low-alloy steel. Mayari R has a yield point of 50,000 psi min, an endurance limit of approximately 50,000 psi, high corrosion resistance and excellent workability and weldability.

RESISTANCE TO FATIGUE—Mayari R steel's endurance limit is unusually high—about 50,000 psi (60 to 75 pct of its tensile strength of 70,000 psi minimum). In addition, Mayari R steel is extremely ductile, with 22 pct minimum elongation in 2 in. Pipe fabricated from Mayari R plate has the exceptional endurance strength, extreme ductility and high impact qualities needed for handling vibration, pulsation and variable shock-loadings.

LIGHTER WALLS—When you use Bethlehem High-Strength Gas Pipe you can specify much lighter walls than with ordinary carbon-steel pipe. This results in savings in material, as well as in the cost of transportation, handling and field welding.

WELDS READILY—Bethlehem High-Strength Gas Pipe is readily welded by following normal field-welding procedures, using mild steel electrodes.

FOR NORMAL PIPELINE SERVICE we recommend Bethlehem Gas Pipe fabricated from carbon steel, meeting specifications ASTM A134 or API 5LX42. Comparative weights and test pressures for these grades of pipe, as well as for pipe made from Mayari R, are shown in the table below.

All grades of Bethlehem Gas Pipe are made in 40-ft lengths, with beveled or square ends, and in all diameters from 18 in. OD. We can grit-blast, prime, coal-tar enamel and wrap the pipe to your specifications.

A phone call or letter to the nearest Bethlehem sales office will bring you full information about Bethlehem Gas Pipe, in Mayari R or carbon-steel grades.

Comparative Maximum Test Pressure: MAYARI R, API 5LX42 and ASTM A134 Steel Pipe

Pipe OD In.	¼ IN. THICK				⅜ IN. THICK				½ IN. THICK				¾ IN. THICK				1 IN. THICK			
	Wt lb per ft	Test Pressure psi Mayari R	API 5Lx42	ASTM A134*	Wt lb per ft	Test Pressure psi Mayari R	API 5Lx42	ASTM A134*	Wt lb per ft	Test Pressure psi Mayari R	API 5Lx42	ASTM A134*	Wt lb per ft	Test Pressure psi Mayari R	API 5Lx42	ASTM A134*	Wt lb per ft	Test Pressure psi Mayari R	API 5Lx42	ASTM A134*
18	49	1180	990	665	73	1770	1490	960	96	2360	1985	1275								
20	54	1120	920	575	81	1590	1340	860	107	2130	1785	1150								
22	63	965	820	520	93	1450	1220	815	118	1935	1630	1040								
24	67	885	750	475	99	1330	1120	745	130	1770	1490	955								
26	73	820	690	440	107	1225	1030	690	141	1635	1380	880	202	2450	2050	1325				
28	79	760	640	405	117	1140	955	640	153	1515	1275	820	219	2270	1910	1225				
30	85	710	595	380	125	1060	895	600	164	1415	1190	765	235	2130	1785	1145				
32	92	665	560	355	134	1000	835	560	176	1325	1115	715	252	1990	1675	1075	330	2650	2230	1430
34	97	625	525	335	143	940	785	505	187	1250	1050	675	268	1875	1575	1010	352	2500	2100	1350
36	105	590	495	315	152	885	750	480	200	1180	980	635	285	1770	1490	950	374	2360	1980	1275
42	118	505	425	270	173	760	640	410	228	1010	850	545	334	1525	1275	815	440	2020	1700	1090
48	135	440	375	235	199	665	560	360	263	885	745	475	384	1325	1115	715	506	1770	1485	955
60	170	355	300	190	252	530	450	285	331	710	595	380	483	1060	890	570	638	1415	1190	765
72	210	295	250	160	306	440	375	240	403	590	497	320	582	885	740	475	770	1180	990	635
84	238	250	215	135	353	380	320	205	464	505	425	270	672	755	635	410	902	1010	850	545

*ASTM A283 Grade B, to be used when ordering to ASTM A134 Specification. If ASTM A283 Grade C is used instead, the test pressures may be increased by 11 pct. Pipe can be furnished in diameters intermediate to those shown above.

Test pressures above are based on stressing steel to 85 pct of minimum yield point:
Mayari R—85 pct of yield point = 42500 psi
API 5LX42—85 pct of yield point = 35700 psi
ASTM A134—85 pct of yield point = 22950 psi
Formula used: $P = \frac{2ts}{D}$

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

For more data on advertised products, use Readers' Service Cards, last page.

The guy on the right is Joe Roughneck. He's the brains and the brawn of the oil industry. Whether he is on a rig in the field or whether he has moved up to be president of his company . . . he knows oil . . . and pipe.

And there's another thing Joe knows . . . that just around the corner is Lone Star, a completely integrated steel mill whose specialty is manufacturing API casing, line pipe and tubing. Top quality . . . quick delivery . . . largest mill stock in the Southwest . . . homefolks . . . it's a natural, as "natural" as six-ace, or five-deuce!

Neighbor, wherever you are, specify Lone Star . . . and we both get a good deal!

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than $1 million accounted for less than 8 percent.

The study found that the largest number of acquisitions in the seven-year stretch were in the non-electrical machinery industry with 249 mergers and in the food products field with 243. Together they accounted for more than one-fourth of the 1773 mergers in manufacturing and mining during that period. The next ten industry groups in which mergers were most numerous were: Chemicals, 168; fabricated metals, 161; transportation and equipment, 125; textiles and apparel, 117; electrical machinery, 111; non-manufacturing, 96; mining, 81; primary metals, 78; stone, clay and glass, 70; and paper and allied products, 60.

The nearest the report came to condemning the merger movement was this statement: "The operation of these forces on a large scale carries with it such adverse economic effects on third parties, and on the economy as a whole, as to bring their unrestrained operation into conflict with existing law." It added, however, that "in policing such situations, there is sound basis for interference with the freedom of either individuals or corporations to acquire or dispose of property only where, on the basis of considered judgment, it can be shown that adverse effects on competition, and hence on the public interest, outweigh the benefits of individual and corporate freedom of action."

Why they merge. According to the study, factors which frequently lead to mergers include the desire for additional plant capacity or diversification of products, and the desire to serve new markets or to gain new sources of supply. Tax savings is another prime mover.

"Conclusions concerning the competitive consequences of particular acquisitions cannot be reached on the basis of rules-of-thumb." Thus, every merger should be individually studied to determine its effects on the market and on other companies. Any acquisition, said the report, which substantially reduces the opportunity or incentive of sellers or buyers to enter new markets, to experiment with new channels of sale or distribution, or to exercise choice among products and prices, may substantially lessen competition.

Order from your TUBE TURNS' Distributor!

PIPE LINE WELDING ELBOWS are available not only in 45° and 90° types, but in odd angles as well . . . in sizes as large as 42". Specify "TUBE-TURN"* and save valuable time in the field. Get the benefit of Tube Turns' pioneering and research through your nearby Tube Turns' Distributor who can fill all your requirements promptly from the world's most complete line of welding fittings and flanges.

***TUBE-TURN** Welding Elbows are outstanding for true circularity and uniform wall thickness. Odd angles can be furnished as factory-made fittings to any specification as illustrated in the photo at the top of this page.*

TUBE-TURN Welding Fittings and Flanges are made in U.S.A. They meet *all* U.S. piping code specifications.

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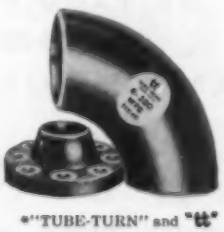

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ARE ALL YOU NEED

no matter what passes thru your valves!

No matter what the fluid or its temperature, Desco Lubricants are guaranteed to STAY in your valves . . . and 4 types are all you need.

Desco Lubricants will not harden or coke-up because they are ALL lubricant and contain no inert material.

CONVENIENT STICKS OR BULK

Packed in clean, convenient sticks in 5 sizes for gun or jack screw. Also in 5-quart, 5-gallon, 100 lb. and 400 lb. bulk containers.

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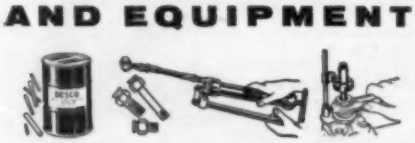

LUBRICANTS FITTINGS GUNS LUBRICATORS

WHAT'S HAPPENING

IN PIPE LINE CONSTRUCTION

Southern Pacific Awards Contracts On Los Angeles-El Paso Products Line

By **MELVIN A. JUDAH,** PIPE LINE INDUSTRY Staff

Construction is underway on Southern Pacific Pipe Line's 846-mile products line from El Paso, Texas, to Watson, Calif. Pipe is now being laid on the first section west of El Paso to Lordsburg, N. M., with 37 miles in the ground.

Engineering design details for the line are complete. All pipe has been ordered and delivery which began in May will continue through August. Stringing will be by truck from railhead delivery points. Plans call for welding and wrapping over the ditch, except for the section of 16-inch from Watson to Colton, Calif, which will be yard-coated and racked at Watson.

Three pumping stations will be built to move products west from El Paso and east from Watson. A common terminal for both lines will be at Phoenix. Three centrifugal pumps, each driven by a 300 hp electric motor, will give the Watson station an initial capacity of 39,000 barrels daily. Provisions allow for increasing to 58,000 in the future. The Colton station will be the workhorse of the system with a total horsepower of 2700. Three centrifugal pumps will be driven by three 900 hp electric motors to move 28,000 barrels of products per day with future possibilities of increasing to 38,000. Two centrifugals, each driven by a 300 hp electric motor will give the El Paso station an initial capacity of 13,000 barrels daily with a future potential of 21,000.

Construction contracts on the line will add up to about $5 million. Bulk of the line cost, $25 million, has been allocated to materials, pumping stations, terminals and project costs. Design and construction of the line is being handled by Engineering Management Inc. Plans call for the line to be constructed in eight schedules as follows:

Schedule 1: El Paso to Lordsburg, N. M., 158 miles of 8-inch. Contract let to Morrison-Knudsen Company of Los Angeles. Approximately 37 miles of pipe now is in the ground.

Schedule 2: Lordsburg to Tucson, Ariz., 145 miles of 8-inch. Contract let to R. H. Fulton and Company of Lubbock, Texas. Pipe welding on this schedule to start about July 12.

Schedule 3: Tucson to Hassayampa, Ariz., (via Phoenix), 122 miles of 8-inch pipe and 35 miles of 12-inch pipe. Contract let to Hood Construction Company of Lynwood, Calif. Construction to start about August 15.

Schedule 4: Hassayampa to Yuma, Ariz., 128 miles of 12-inch pipe. Contract let to Macco Corporation and Alex Robertson Company of Paramount, Calif. Construction to start about August 1.

Schedules 5 and 6: Yuma to Colton, 197 miles of 12-inch. Contract let to Conyes Construction Corporation of San Pablo, Calif.

Schedules 7 and 8: Colton to Watson, 61 miles of 16-inch pipe. Contracts have not been let.

Buckeye Announces 1955 Construction Plans

The Buckeye Pipe Line Company has scheduled three projects for completion in late 1955. A 14-mile 10-inch crude line will be built from Wayne, Mich., to Detroit. Buckeye will also extend its products system from Lima, Ohio, to Ft. Wayne, Ind., to handle products from the Toledo area.

An existing 8-inch crude line between Toledo and Cleveland will be reconditioned for products service. To move the products, a new pump station and additional tankage will be built at Toledo. Products will be received from the Wolverine Pipe Line system and from refineries in the Toledo area for delivery to terminals at Cleveland. Work on this project is to be completed in early October.

Great Lakes to Boost Des Moines Line Capacity

Great Lakes Pipe Line Company plans to increase the capacity of its Des Moines-Iowa City, Iowa, products line with a 12-inch loop before the heavy fall load begins this year. From the Des Moines station, the 106-mile line will parallel existing 6 and 8-inch lines. The added capacity will serve Great Lakes terminals at Iowa City and Chicago and connect with other terminals at Amboy, Ill., and Madison, Wis.

Spanish Air Bases Line Contracts Are Awarded

Contracts have been awarded to B & M Construction Corporation of Tulsa, Merritt-Chapman and Scott Corporation, of New York, and the Spanish firm of Agroman Empresa Construction of Madrid for a 475-mile products line to serve U. S. Air Force bases in Spain.

The pipe line will run from the Atlantic seaport of Rota, near Cadiz, to Zaragoza in northern Spain. Products will be delivered from the seaport to six bases at Rota, San Pablo, Moron, Torrejon, Valenzuela and San Jurjo. The 150-mile section from Rota to Adamuz will be 12-inch; a 190-mile section between Adamuz and Madrid will be 10-inch; and the final 150 miles to Zaragoza will be 8-inch line. Pipe is being supplied at a cost of $5,264,426 by the British firm of Steward & Lloyd.

Pumping stations will have an unusual reversibility feature. Each one, except the one at Rota, is so designed that it will be capable of pumping in a reverse direction at any rate up to its capacity in the forward direction. Station manifolding is being fitted with this aim. With this provision, if there is a break in the line, products may be pumped back down the line to serve bases when needed.

Prime contractors for the Spanish air bases project are Brown-Raymond-Walsh, a joint venture group composed of Brown & Root, Inc., Houston; Raymond Concrete Pile Company, New York; and Walsh Construction Company of Davenport, Iowa.

Architects-Engineers Spanish Bases is doing the engineering work on the line.

Construction is due to begin about July 15. Most of the personnel to be used in construction of the line will be Spanish.

"steady as a rock" in any weather

Typical Emsco guyed microwave installation in Oklahoma.

Emsco microwave towers are sturdy, steady . . . assure dependable microwave operations. Unique bridle guying of the tower top holds torsional deflection to a minimum.

A pair of guys on each side of Emsco towers are anchored in a reverse direction. If the tower tends to twist because of wind, three of the guys will tighten and hold deflection of the tower top within specifications.

Every Emsco tower design meets RETMA specifications. Hot Dip Galvanizing provides protection against corrosion. Bolted construction permits quick, sure visual inspection.

For guyed or self-supporting towers unequaled for safety, structural rigidity and economy . . . specify Emsco. Prompt delivery is assured.

E-214-55

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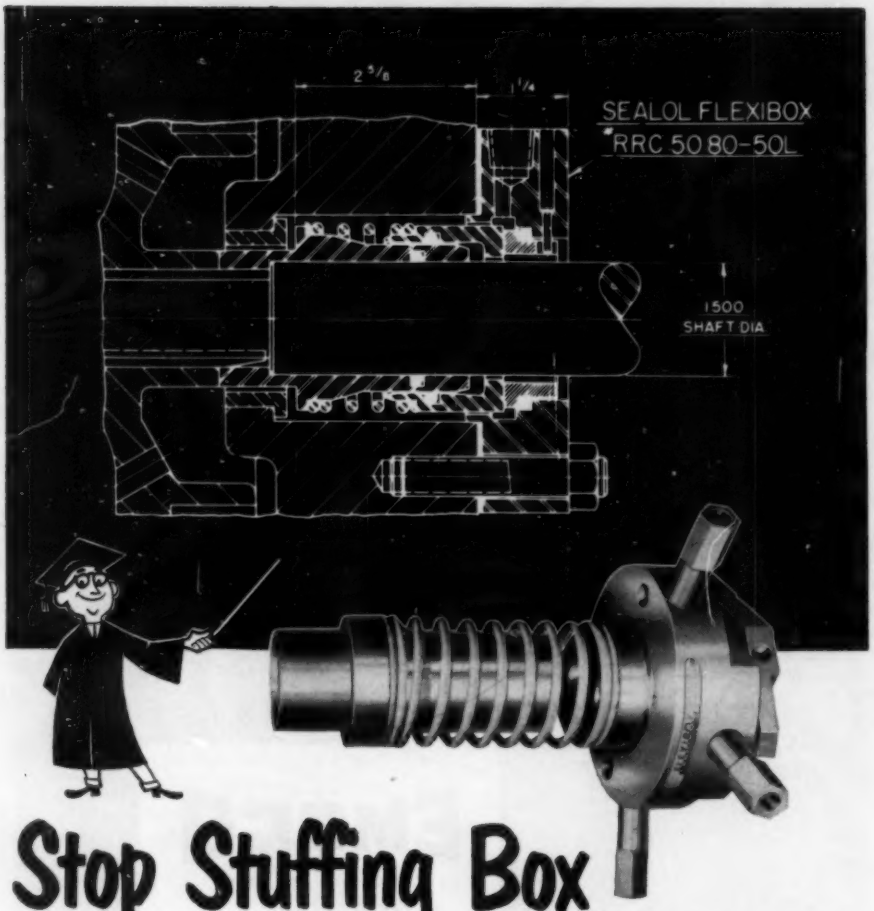

Stop Stuffing Box Leakage NOW!

Your pumps can be sealed positively by Sealol-Flexibox mechanical shaft seals engineered specifically for your pipeline pressures. By eliminating gland leakage, Flexibox prevents waste of valuable product and avoids the constant fire hazard of escaping volatiles.

Sealol-Flexibox engineering experience gained in successfully sealing pipeline pumps for major petroleum companies throughout the world is ready to go to work on your specific applications. Let us submit recommendations for mechanically sealing your pumps, including a detailed analysis of piping connections and control valves essential to proper seal installation. Send for Bulletin 10 describing Flexibox Seals.

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St. Louis • Tulsa • Edmonton — Toronto (Can.) • Manchester (Eng.) • Paris • Frankfurt

SEALOL

THE BALANCED PRESSURE SEAL

In laying Shell's line through south Louisiana swampland, a lookout was stationed on the plugged end of the pipe line as it was pushed along the ditch. By using the pole to probe ahead of the pipe, he could locate any obstruction and signal to the bulldozer operators, out of sight back down the line.

Shell's Norco-Baton Rouge Products Line in Service

Shell Pipe Line Corporation recently began movement of products through the new 65-mile 12-inch line from Shell Oil's Norco, La. refinery to a junction with Plantation Pipe Line at Baton Rouge. Construction of a new pumping station near Norco will give the line a capacity of 50,000 barrels daily to take added output from the expanded Norco refinery.

One of the toughest phases of construction was laying of the line through 12 miles of swamp along New Orleans' Airline Highway. Shell Pipe Line did the engineering on the line and Houston Contracting Company had the construction contract.

Court, FPC Clears Way For American Louisiana Line

American Louisiana Pipe Line Company recently cleared several legal barriers in the construction of its Louisiana to Detroit gas line and has let contracts for construction of 783 miles of the 30-inch line.

Early last month, the U. S. Supreme Court removed one of the last major

hurdles when it refused to grant Panhandle Eastern Pipe Line Company a hearing on its objection to the American Louisiana project. Two weeks later the FPC denied several petitions for rehearing of the order authorizing four independent producers to sell to American Louisiana. At the same time the FPC approved the financing program for the proposed project.

One contract has been awarded in a joint venture to H. C. Price Company and to Houston Contracting Company for construction of the first 783 miles of the 30-inch main line from Willow Run, Mich., to Eudora, Ark., on the Arkansas-Louisiana state line. Work on the $130 million project is scheduled to get underway this month.

Contracts Let on Butte's Crude Pipe Line Project

Four contracts have been awarded for construction on the 452-mile crude oil pipe line of Butte Pipe Line Company in Wyoming and Montana. Shell Pipe Line Corporation is acting as agent on the project. Others interested in the line are Murphy Corporation, Placid Oil, and Northern Pacific Railway.

Associated Pipe Line Contractors, Houston, will build 227 miles of 16-inch from the Montana-Wyoming state line south to Guernsey, Wyo. O. R. Burden Construction Company, Tulsa, has the contract to build a section of the line in southeastern Montana. Included in this section will be 15 miles of 12-inch and 88 miles of 16-inch. Anderson Brothers will build 88½ miles of 10-inch from Poplar to Glendive, Mont. An existing section of 12-inch line 33 miles long will be incorporated in the new line south of Glendive.

Work is now underway with completion planned for the end of the summer if weather stays favorable for construction.

Texas Gas Transmission To Start Loop Construction

Construction of 77 miles of 26-inch pipe line consisting of six loops on the main transmission line of Texas Gas Transmission Corporation is scheduled to get underway soon.

In addition to these loops in Tennessee and Kentucky, 74 miles of 12-inch line will be laid in Kentucky and Indiana, and 35 miles of 10-inch and 5 miles of 8-inch will be laid in Indiana. H. C. Price is the contractor on all of the lines.

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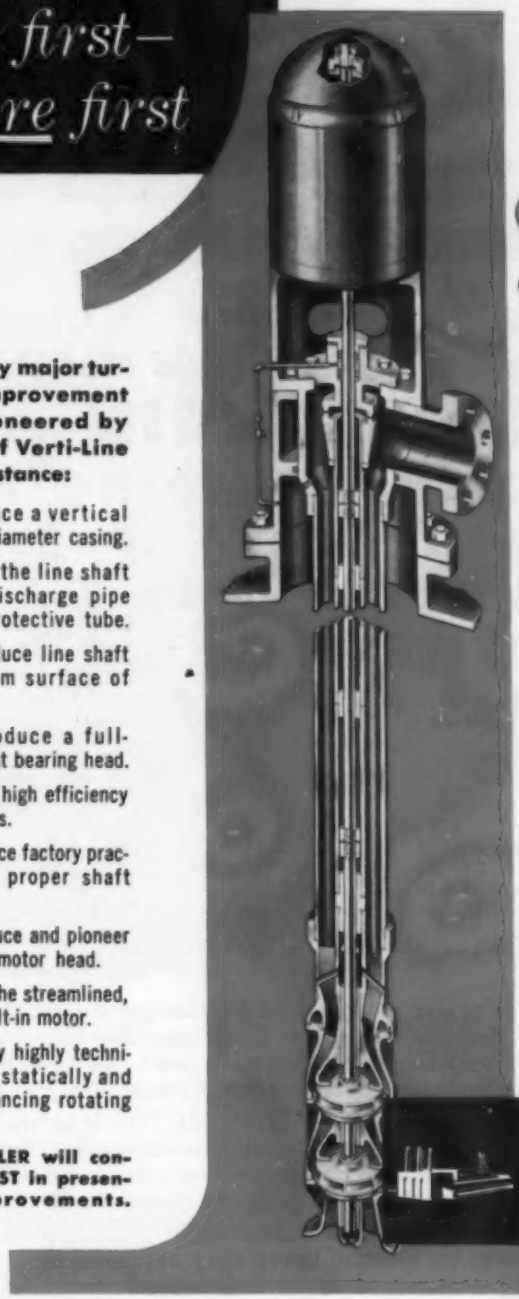

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FPC Changes to Simplify Gas Certificate Applications

The FPC has announced proposed changes in its rules and regulations aimed at simplifying and clarifying provisions related to natural gas rate filings and certificate applications. Proposals came from conferences among FPC staff and representatives of the Federal Power Bar Association, the Independent Natural Gas Association and the Hoover Commission.

Some changes involve notice requirements in the filing of gas rate schedules and affect both pipe line companies and independent producers. Provisions involved in gas certificate applications include changes related to gas supply data, exhibits pertaining to revenues, expenses and income, and reports on construction and completion of authorized facilities. Amendments also provide that all gas volumes shall be stated on a uniform basis of measurement.

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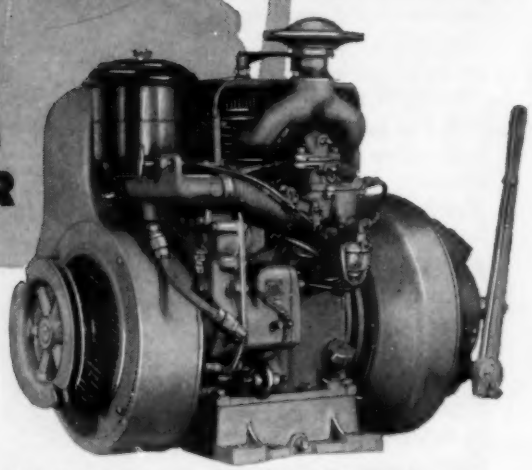

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Texas Eastern Files Amends To Big-Inch Shift Plans

The FPC has given unanimous approval to Texas Eastern Transmission Corporation for removal of a major section of the Little Big Inch system from gas service and for construction of substitute facilities. Close on the heels of the FPC action, Texas Eastern has asked for approval to use larger pipe and modify compressor facilities in replacement lines.

Under FPC action, Texas Eastern would construct substitute facilities to maintain gas delivery capacity and go ahead with reconversion of about 1168 miles of its Beaumont, Texas, to Moundsville, W. Va., line to products service. The products line will be operated as a division of the parent company under ICC regulations, said George T. Naff, Texas Eastern President.

Originally, construction plans for substitute gas facilities called for construction of a 382-mile 24-inch pipe line from Beaumont to Kosciusko, Miss. This line would have cost $71.8 million in addition to the $14.8 million spent for reconversion of the Little Big Inch line.

Recent engineering surveys by Texas Eastern have shown that a 30-inch line with modern gas turbine and centrifugal compressor stations could be built to handle the required capacity at a cost of only $70.8 million; saving about $1 million, yet allowing for future expansion. With this in mind, Texas Eastern has asked the FPC for permission to amend the certificate previously issued to authorize construction of the 30-inch facilities.

Financing arrangements have already been completed for $40 million of the approximately $86 million required for the project.

Colorado Interstate Begins Denver-Rock Springs Line

Colorado Interstate Gas Company has started construction on the first section of its 380-mile Denver to Rock Springs, Wyo., gas line. Clearing of right-of-way is already in progress and line construction is due to start early this month. The first section will extend from Colorado Interstate's East Denver control station to a point about three miles southwest of Laramie, Wyo. Plans call for laying about 140 miles of 22-inch line within four months.

Three meter stations will be located

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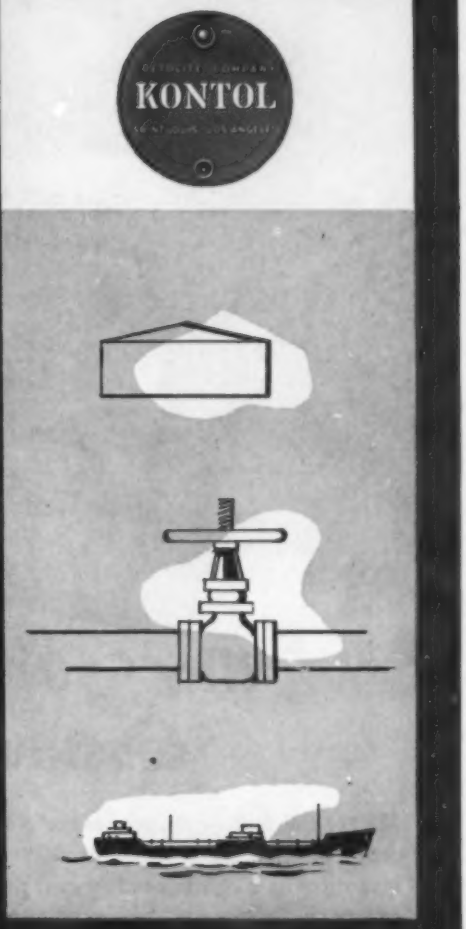

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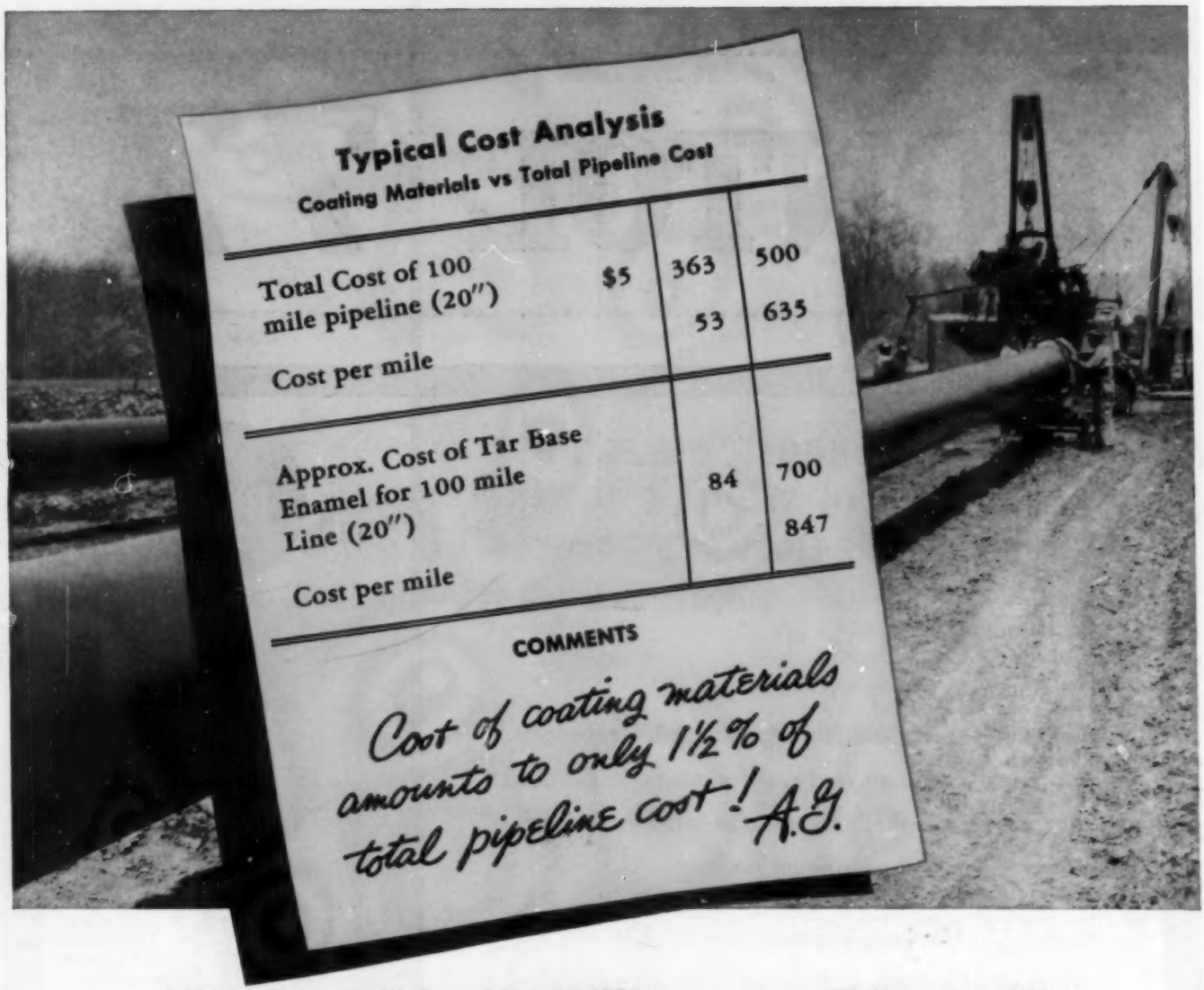

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near Cheyenne, Wyo., at Greeley, Colo., and at the East Denver station.

Estimated cost of the line is $8 million. Houston Contracting Company is the contractor on this section. Remainder of the 380-mile line, which will run from Laramie to a connection with Pacific Northwest Pipe Line at Rock Springs, is scheduled for construction in 1956. When completed it will link the Colorado Interstate system through Pacific Northwest to the San Juan Basin and to western Canadian gas fields.

Northern Natural Plans Underground Storage Test

In a recent application with the FPC, Northern Natural Gas Company seeks to build and operate 28.4 miles of 30-inch pipe line to an underground natural gas storage field near Redfield, Iowa.

Transco Adds Suppliers In 1955 Expansion Program

In the largest single purchase since its Texas to New York line was put into service, Transcontinental Gas Pipe Line Corporation added 40 million cubic feet per day to its system. The gas is now being delivered from Texas Gas Pipeline Corporation's new 1600-horsepower compressor station near Orange, Texas. Transco constructed a 27-mile 12-inch purchase lateral from its trunkline near Starks, La., to receive the gas.

Three other suppliers have received FPC authorization to deliver gas to Transco as plans move along in the company's $83 million 1955 construction program.

Dixie Pipe Line Company has been authorized to construct 20 miles of line in Jefferson Davis County, Miss., to extend from the Gwinville field to Transco's line. Dixie may sell from 14.4 to 25 million cubic feet daily to Transco. Estimated cost of the Dixie line will be $425,000.

Another certificate has been issued to the Gwin Company approving sale of gas purchased in the Gwinville field to Dixie for resale to Transco. Gwin plans to build about 20 miles of delivery line at an estimated cost of $432,000.

Transco will also receive gas from six producers in the South Bayou Mallet, Maxie, and Happytown fields in Louisiana following recent FPC approval. To receive the Louisiana gas, Transco will construct about 24.2 miles of line at an estimated cost of $754,000.

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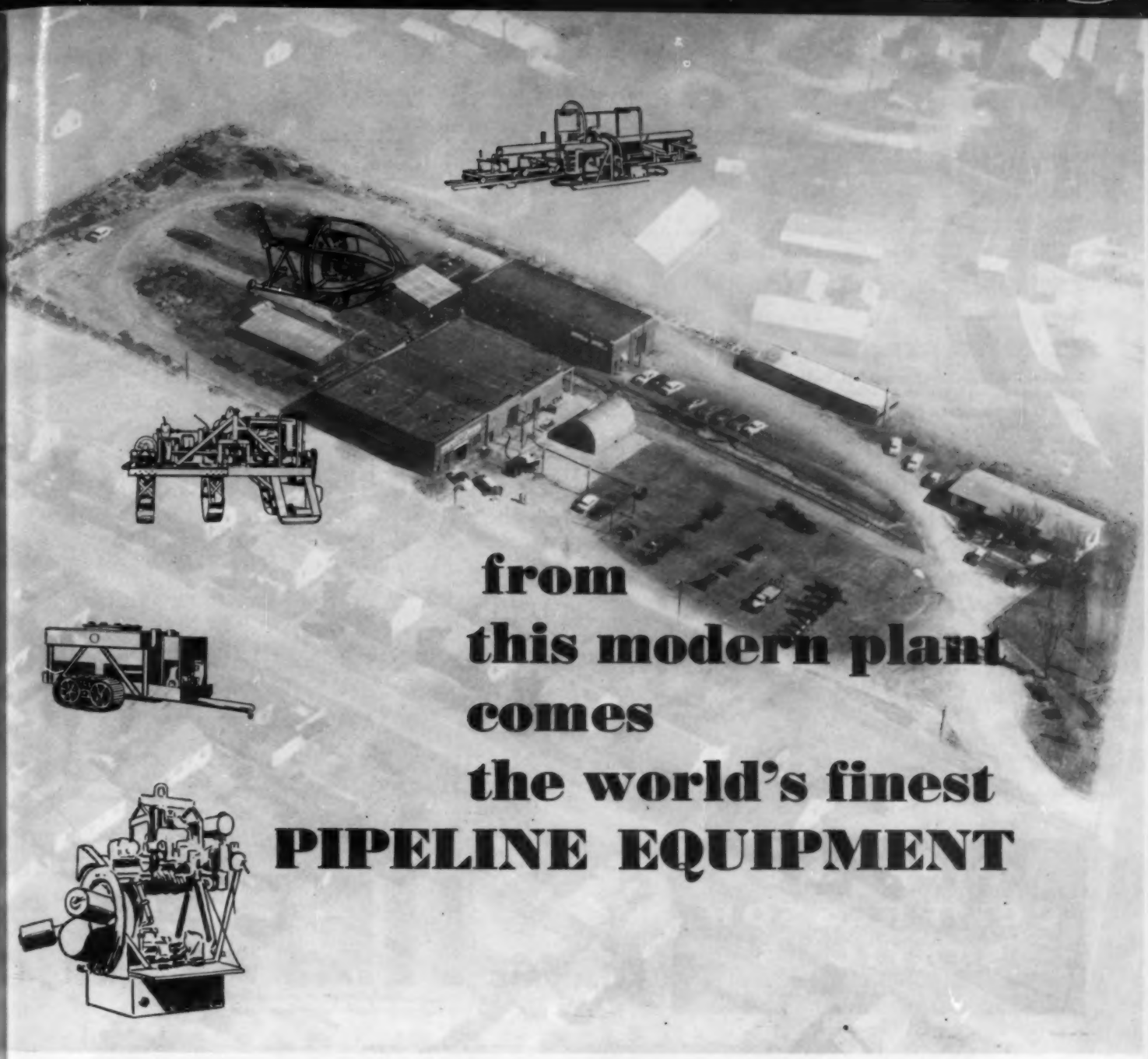
Pipe Line Contracts Not Let

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Alabama-Tennessee Natural Gas Co.—Florence, Ala.	25	8, 12	Gas	Colbert County, Ala. loop.	$808,450	3.7 miles authorized
American Louisiana Pipe Line Co.—666 Penobscot Bldg., Detroit, Mich.	506	22, 30	Gas	North Tepetate, La.—Detroit, Mich.	$130 million	783 miles let
American Pipe Line Corp.—New York City (Swinerton & Walberg, Engineering)	1,425 plus 485 miles feeders & distribution lines	24, 26	Products	Beaumont, Texas area—Newark, N.J.	$170 million	Planned
Anadarko Basin Pipe Line Co.	525	24	Gas	Wise County, Texas—Texas Eastern near Memphis, Tenn.	.....	Planned
Arkansas-Louisiana Gas Co.	66	24	Gas	Arkansas, Louisiana and Texas loops	$9,245,166	Authorized
Ar-Mex Pipe Line Co.	900	8, 12, 14	Crude	Guernsey, Wyo.—Phoenix, Ariz.	$31 million	Planned
Attock Oil Co.	60	....	Gas	Dhulian Field—Rawalpindi, West Pakistan.	.....	Planned
H. W. Bass & Sons, Inc.	152	4, 6	Products	Live Oak County, Texas—Corpus Christi, Texas	.....	Planned
Big Horn Pipe Line Co.—Cheyenne, Wyo.	150	8	Crude	Ash Creek, Wyo. field—Midwest, Wyo.	.....	Proposed
Buckeye Pipe Line Co.	14	10	Crude	Wayne—Detroit, Mich.	.....	Proposed
California-Oregon Pipe Line System	103	6	Crude	Crescent City, Calif.—Medford, Ore.	$2 million	Planned
Carolina Natural Gas Corp.—701 Wilder Bldg., Charlotte, N.C.	185	2, 12	Gas	North and South Carolina	.....	Proposed
Central Hudson Gas & Electric Co.	48	12	Gas	Albany—Kingston, N.Y.	.....	Applied to FPC
Cities Service Gas Co.—1st National Bank Bldg., Oklahoma City, Okla.	33	20, 26	Gas	To replace lines in Kansas and Missouri	$1,860,000	Authorized
	13	....	Gas	Labette County, Kansas	$285,000	Authorized
	15.5	16	Gas	Carter County—Garvin County, Okla.	$541,050	Authorized
	11.5	2, 4, 8	Gas	Johnson and Cass Counties, Mo.	$140,000	Before FPC
	93	26	Gas	Blackwell, Okla.—Independence, Kan., plus 145 miles of gathering lines	$8.4 million	Before FPC
City of Dalton Ga.	39	8	Gas	To connect with Southern Natural Gas Co. line	$2,940,000	Proposed
Clinchfield Coal Corp.—Dante, Va.	16	12	Gas	Dickenson County, Va.—Osborne Gap, Ky.	$785,000	Before FPC
Coastal Transmission Corp.—Houston, Texas	500	30	Gas	McAllen, Texas—Louisiana connection, Houston, Texas Gas.	$110 million	Considered
Coast Counties Gas & Electric Co.—369 Pine St., San Francisco	40	3, 4, 8	Gas	Coast and Valley region, Calif.	.....	Planned
Colorado Interstate Gas Co.	115	4, 6, 8	Gas	Denver—Julesburg Basin—Basin Cities	.....	Before FPC
	328	16, 18	Gas	LaPlata County—Pueblo, Colorado Springs and Denver	$21,600,000	Authorized
Compania del Oleoducto Buenaventura—Cali, Colombia, S.A.	90	....	Products	Buenaventura—Cali, Colombia, S.A.	$4 million	Planned
Consolidated Gathering Systems, Ltd.	198	....	Crude	Sturgeon Field—Edmonton.	.....	Planned
Consolidated Natural Gas Corp.—New York	112	....	Gas	In Ohio—Plus other smaller lines	$6 million	Planned
Dixie Pipe Line Co.	20	8	Gas	Gwinville Field, Miss.—Transcontinental Gas line	$425,000	Authorized
El Paso Natural Gas Co.—El Paso, Tex.	32.5	10	Gas	Reagan and Upton counties, Texas	$799,030	Authorized
	74	....	Gas	Texas, New Mexico and Arizona	$13,800,000	Authorized
	370	....	Gas	Mountain Home, Idaho—Reno, Nev.	$35 million	Proposed FPC
	500	34	Gas	Parallel from San Juan Basin to Topock, Ariz.	.....	Proposed FPC Alternate
	....	30	Gas	Pendleton, Ore.—Calif.	.....	Proposed FPC Alternate
	31.9	8	Gas	Pinal County, Ariz. Service Line.	.....	Before FPC
Empresa Nacional del Petroleo	80	6	Products	Concon—Santiago, Chile	.....	Planned
Governments of Southern Rhodesia and Portuguese South Africa	200	....	Products	Beria, Portuguese Mozambique—Umtalia, Southern Rhodesia	.....	Considered
Great Lakes Pipe Line Co.	106	12	Products	Des Moines—Iowa City Loop	.....	Proposed
Hope Natural Gas Co.—445 W. Main St., Clarksburg, W. Va.	33	8, 10, 12	Gas	Wyoming County, W. Va.—Buchanan County, Va.	.....	Proposed
Houston Texas Gas & Oil Co.—4604 Main St., Houston	1042	18, 24, 36	Gas	Louisiana—Miami, Fla.	$110 million	Considered
Idaho Natural Gas Co.—Gordland, Kansas	....	....	Gas	Pacific Northwest line—points in Southern Idaho	.....	Proposed
International Pipe Line Co., Inc.—227 N. Colfax Ave., Minneapolis, Minn.	132	8	Products	Wrenshall, Minn.—Minneapolis Bulk Terminal	$4,250,000	Planned
Iraq Petroleum Co.	75	24	Crude	Homs, Syria to Tripoli	.....	Proposed
Kansas-Nebraska Natural Gas Co.—Phillipsburg, Kansas	283	6-12	Gas	Central and northeast Nebraska	$4,096,890	Some contracts let
Kentucky-West Virginia Gas Co.	32	12	Gas	Service line to Maytown, Ky.	.....	Before FPC
Keystone Pipe Line Corp., Philadelphia	48	8	Products	Boot—Fullerton, Pa	$1,875,000	Approved
Lateral Gas Pipe Line Co.—Cedar Rapids, Iowa	27	4	Gas	Grant—Clarinda, Iowa	$267,000	Proposed
Lone Star Gas Co.—Dallas	230	22, 26	Gas	Cotton County, Okla.—Fritch, Texas	$18.7 million	Before FPC
Malco Pipe Line Inc.	91	6	Products	Prewitt, N.M.—Albuquerque	$1,250,000	Planned
Mayflower Pipe Line Co.-(Pine Tree Natural Gas Co.) —70 Pine St., New York, N.Y.	200	....	Products	New Jersey refining area—New England	.....	Planned
Michigan Consolidated Gas Co.—415 Clifford, Detroit	25.5	12	Gas	Sparta—Muskegon, Mich.	$13 million	Proposed
Michigan Gas Storage Co.	36	16	Gas	Mount Pleasant Junction—Zilwaukee, Mich., Underground Storage	$2.6 million	Authorized
Michigan-Wisconsin Pipe Line Co.—500 Griswold, Detroit	252	4-24	Gas	Wisconsin	$11 million	Proposed
Missouri Central Gas Co.	25	6	Gas	Moberly—Macon, Mo.	.....	Proposed
Missouri Public Service Co.—Warrensburg, Mo.	136.4	8-10	Gas	New Franklin, Mo.—Grundy County, plus laterals	$5 million	Proposed
Montana-Dakota Utilities Co.—Minneapolis	56	2, 4, 6	Gas	Hettinger and Stark counties, N.D.	$728,854	Authorized
	30	16	Gas	Service lines and compressor facilities at various locations	$1.9 million	Before FPC
Moore-Stoner Co.	200	6	Products	Glendive, Mont.—Minot, N.D.	$2,000,000	Planned
NATO	1920	4-10	Products	To serve military bases in Western Europe	.....	Foster-Wheeler Prime Contractors
Natural Gas Pipe Line Co. of America—20 N. Wacker Dr., Chicago	350	20, 26	Gas	Wise County, Texas—Fritch, Texas	$28.5 million	Before FPC
Natural Gas Producers, Inc.—Colorado Springs	61.8	12	Gas	Yenter Pool—Denver	$1,374,000	Planned
	49	10	Gas	Denver-Julesburg Basin—Fort Morgan, Brush and Denver	.....	Planned
Natural Gas Storage Co. of Illinois—Chicago	35	36	Gas	Delivery from Herscher, Ill. storage field.	$7 million	Before FPC
Nebraska Pipe Line Co.	220	6	Products	Cheyenne, Wyo.—North Platte, Neb.	$4 million	ODM certificate granted
Nevada Natural Gas Co.	114	12, 16	Gas	Various loops along Needles, Calif—La Vegas, Nev. line	$2.5 million	Planned
New River Gas Co.	50	....	Gas	Summers-Monroe Counties, W. Va. and Narrows and Dublin, W. Va.	.....	Planned
New York State Natural Gas Corp.	21	20	Gas	Loop in Wyoming and Livingston Counties, N.Y.	$1.2 million	Authorized
NNCW Pipe Line Co.—Dallas, Texas	127	8, 10	Crude	Clareton Field—Casper, Wyo.	$3.6 million	Planned
Northern Natural Gas Co.—2223 Dodge St., Omaha	167	24	Gas	Farmington, Minn. to Duluth, Minn. and Superior, Wis.	$12 million	Before FPC
	329	2, 12	Gas	Sioux Falls to Aberdeen, S.D.	$6,661,100	Proposed
	....	....	Gas	To interconnect with Natural Gas Pipe Line	$244,000	Planned
	403	24, 30	Gas	Emerson, Manitoba, Canada—Farmington, Minn.	$32,813,000	Before FPC
	28.4	30	Gas	Test lines to underground storage near Redfield, Iowa	$4.8 million	Before FPC
Northwestern Utilities, Ltd.—10124-104th St., Edmonton, Alberta, Canada	42	12	Gas	Bonnie Glen—Edmonton, Alberta	$1.4 million	Proposed
Ohio Fuel Gas Co.	18.9	16	Gas	Loop present lines	.....	Before FPC
Pacific Gas & Electric Co.	135	34	Gas	Topock, Ariz.—Milpitas, Calif.	.....	Planned
Pacific Northwest Pipe Line Corp.—M & M Bldg., Houston	1466 plus 443	22, 26	Gas	San Juan Basin—Pacific Northwestern states	$163 million	Authorized—Contracts let for 665 miles
Panhandle Eastern Pipe Line Co.	58	16	Gas	Springfield—Peoria—Illinois Loop	.....	Before FPC
Pawnee Pipe Line Co.	15	8	Crude	Northeast Colorado Sector—Denver-Julesburg, Basin	.....	Planned
Permian Basin Pipe Line Co.	11	6	Gas	Lea County, N.M.	.....	Before FPC
Petroargentina	370	16	Crude	Newguen—Bahia Blanca, Argentina	$40 million	Planned
Petroleos Mexicanos—Ave. Juarez, 94, Mexico City	440	20	Gas	Brazil—Tampico—Poza Rica, Mexico	.....	Planned
	260	6, 8	Products	Lagos, Mexico—Guadalajara, Aguascalientes and Salamanca	.....	Planned
	145	12	Crude	18 de Marzo Field—Monterrey, Mexico	.....	Considered
	72	12	Crude	Poza Rica—Atascapotsalco, Mexico	.....	Proposed
Phillips Petroleum Co.—Bartlesville	54	6	Products	Goldsmith—Borger, Texas	.....	Planned
S. & M. Pipe Line Co., Ltd.	100	8, 10	Crude	Midale, Forbisher, Steelman, Lampman, Alida, and Nottingham, Sask. to Crome, Manitoba	.....	Proposed



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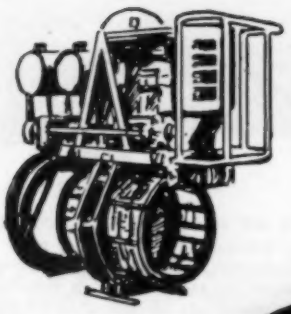

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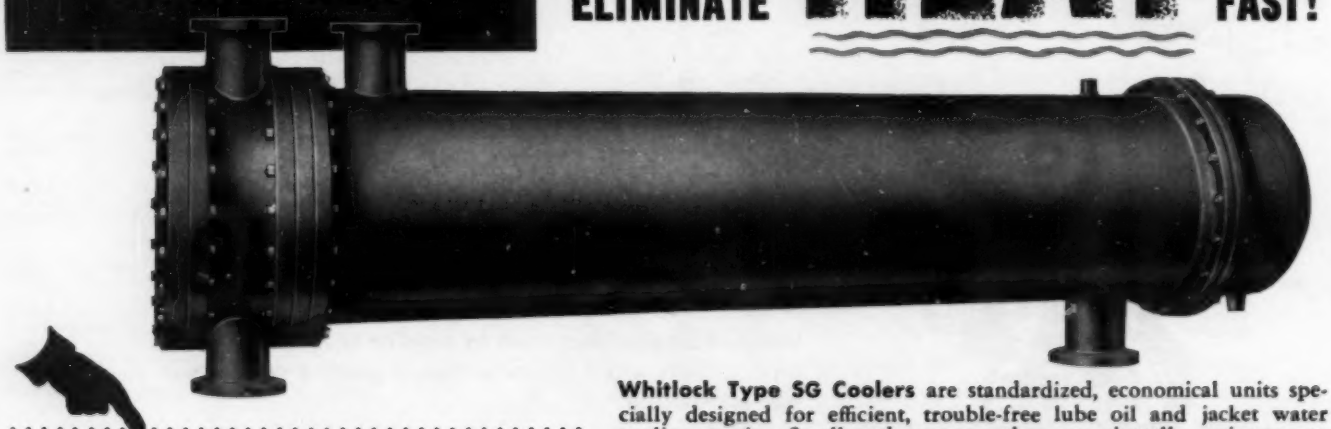
Pipe Line Contracts Not Let—(Continued)

COMPANY	Length in Miles	Diameter	Type	Origin and Terminus	Estimated Cost	Status
Salt Lake Pipe Line Co.	....	....	Products	El Paso, Texas—Albuquerque, N.M.	$4 million	Planned
Santos Jundiai Railway Co.—Brazil	....	8, 14, 22	Crude & Products	Expansion of Santos—Sao Paulo system	$5 million	Planned
Shell Pipe Line Corp.	22	6	Crude	Ropes Field, Texas	.....	Proposed
	15	4	Crude	Brahaney Field, Texas	.....	Proposed
Shenandoah Gas Co.—Lynchburg, Va.	40	3, 4, 8	Gas	Virginia Gas Transmission Co. System—Virginia and West Virginia towns	$1,470,000	Authorized
Sioux Oil Co.	50	8	Products	Newcastle, Wyo.—Rapid City, S.D.	$1 million	Planned
Southern California Gas Co. and Southern Counties Gas Co.	....	30	Gas	Topock, Ariz.—Los Angeles	$31 million	Planned
Southern Counties Gas Co.	31.5	30	Gas	Cactus City—Desert City, Calif.	$2.5 million	Proposed
Southern Pacific Pipe Lines, Inc., San Francisco	61	16	Products	Colton—Watson, Calif.	.....	Contracts have been let for 785 miles
Standard Pipe Line Co.	350	16	Crude	Glendive, Mont.—Guernsey, Wyo.	.....	Before ODM
	330	16	Crude	Wink, Texas—Albuquerque, N.M.	.....	Before ODM
Sturgeon Pipe Line, Ltd.	100	12	.....	Sturgeon Lake Field—Trans-Mountain system	$6,500,000	Planned
Sunflower Pipe Line Co.—Tulsa, Okla.	265	3-6	Products	Kearny, Grant and Haskel Counties, Kansas—Wichita, Kansas	$3.5 million	Authorized
Tennessee Gas Transmission Co.—Box 2511, Houston	370	30	Gas	Agua Dulce, Texas—Kinder, La.	$35.4 million	Authorized
	220	26, 30	Gas	Loops in Kentucky and Ohio plus 376 miles of Supply laterals in Texas and Louisiana	$56 million	Before FPC
Texas Eastern Transmission Corp. and Texas Eastern, Penn-Jersey Corp.	11	....	Gas	Loops in Philadelphia area plus compressor facilities	$2.4 million	Before FPC
Texas Gas Corp—Winnie, Texas	40	4-12	Gas	Orange County, Texas—Cameron Parish, La.	$3.5 million	Authorized
Texas Gas Transmission Corp.	190	20	Gas	East Lake Palourde, La.—main trans. line	$20 million	Before FPC
Trans-Canada Pipe Line, Ltd.—Calgary, Alberta	2240	30, 36	Gas	Alberta—Eastern Canada	$297 million	Approved
Transcontinental Gas Pipe Line Corp.—3100 Travis St., Houston	....	....	Gas	Connecting facilities with Texas Eastern Penn-Jersey in Pennsylvania and New Jersey	$131,628	Authorized
	24.2	....	Gas	Gathering Lines from South Bayou Mallet, Maxie and Happytown Fields, La.	$754,000	Authorized
Trans-Prairie Pipelines, Ltd.	24.5	3, 4, 6	Crude	Gathering lines in Midale, Forbisher and Alida oil fields, Canada	.....	Proposed
Triangle Pipe Line Co.	560	12	Products	Arkansas City, Ark.—Covington, Ky.	$24.5 million	Proposed
Trunkline Gas Co.	24	....	Gas	Loop present line	$18.7 million	Before FPC
Union Gas Co. of Canada, Ltd.—Chatham, Ontario	180	24	Gas	Dawn Gas Field to Lamberton County to deliver gas to Dominion Gas Co.	.....	Planned
United Gas Pipe Line Co.	63	16, 20	Gas	Various location in Miss., Ala. and Florida	$8.3 million	Before FPC
U. S. Dept. of Defense	97	....	Crude	Elk Hills Naval Reserve—Los Angeles	$8 million	Considered
U. S. Navy	600	10	Products	Rota—Zaragoza, Spain	$40 million	475 miles let
	450	8	Gas	Gubik Field—Fairbanks, Alaska	$20 million	Planned
Utah Natural Gas Co.	40	16	Gas	Orem—Salt Lake City, Utah	.....	Planned
Virginia Natural Gas Co.	153	....	Gas	Buckingham—Richmond and Portsmouth, Va.	.....	Planned
West Coast Pipe Line Co.—Mercantile Bank Bldg., Dallas	960	24, 26	Crude	Wink, Texas—Norwalk, Calif.	$106 million	Planned
Westcoast Transmission Company, Ltd.	650	30	Gas	Peace River Fields—Sumas, Wash. Connecting with Pacific Northwest Pipeline.	$140 million	Authorized
	....	30	Gas	Peace River Fields—Okanagan Valley	.....	Planned
	.....	....	Gas	Alberta—Quebec	.....	Considered
Wilcox Trend Gathering System, Inc.	16	16	Gas	Loop near Provident, Texas	$2.2 million	Before FPC
Winnipeg and Central Gas Co.	450	4-8	Products	Tioga, N.D.—Winnipeg, Canada	$20 million	Planned
Wyoming Gas Products Corp.	....	....	Gas	Gathering system in Weston County, Wyo. to feed gasoline plant	.....	Planned
Yacimientos Petroliferos Fiscales Bolivianos	170	4	Crude	Bermejo—Tupinza, Bolivia	.....	Planned

PIPELINE COMPRESSOR STATIONS

ELIMINATE HEAT FAST!



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Rules of Thumb

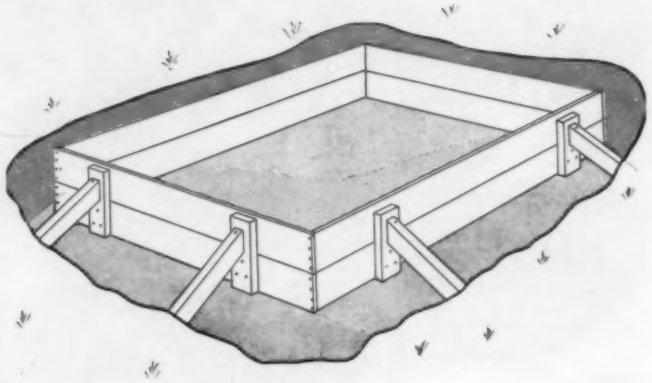
FOR THE PIPELINER'S NOTEBOOK

Pipe Line Construction **—13—How to approximate the number of 94-pound sacks of cement needed to fill a form.**

To obtain a close estimate of the number of sacks of cement that will be required, first determine the volume (cubic feet) to be filled in the form. Divide the volume by 4.86 to approximate the number of sacks of cement needed.

Example: How many 94-pound sacks of cement will be required to fill a form for a concrete base 10 feet by 10 feet if it is to be 6 inches thick?

$$\text{number of sacks} = \frac{10 \times 10 \times 0.5}{4.86} = 10.3 \text{ sacks needed}$$



Engineering Design **—24—Estimate the average pressure in a gas pipe line using the upstream and downstream pressures.**

To find the average gas pressure in a line, first divide downstream pressure by upstream pressure and look up the value of the factor X in the table shown. Then multiply X times the upstream pressure to get the average pressure.

Example: Find the average pressure in a pipe line if the upstream pressure is 775 psia and the downstream pressure is 420 psia.

$$\frac{P_d}{P_u} = \frac{420}{775} = 0.54$$

Interpolating from the table,

$$X = 0.78 + 4/5\ (0.02) = 0.796$$

$$P_{average} = 0.796 \times 775 = 617 \text{ psia.}$$

This method is accurate to within 2 or 3 psi. Here is the same problem calculated with the formula:

$$P_{average} = \frac{2}{3}\left(P_u + P_d - \frac{P_u P_d}{P_u + P_d} \right)$$

$$= \frac{2}{3}\left(1195 - \frac{325{,}500}{1195} \right)$$

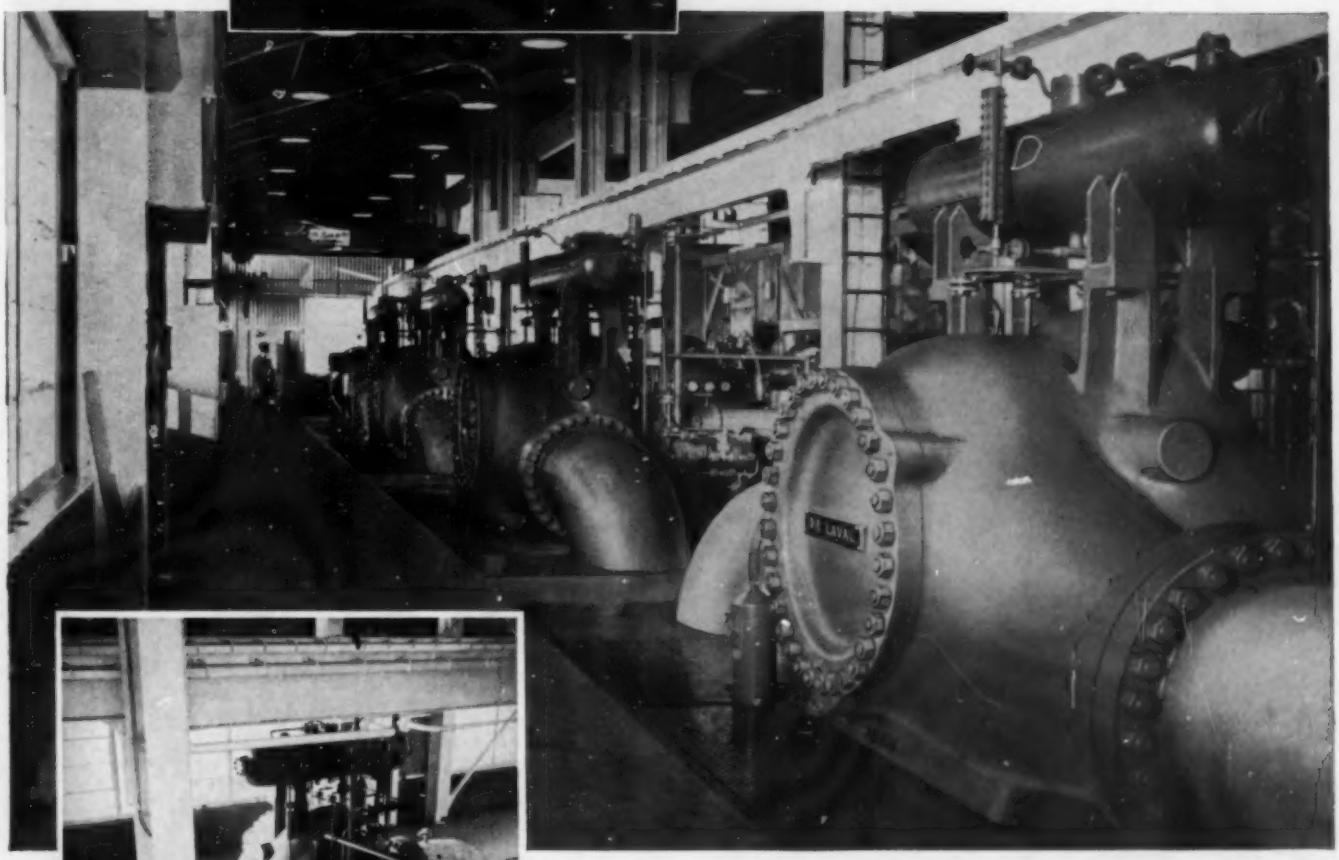
$$P_{average} = 615 \text{ psia.}$$

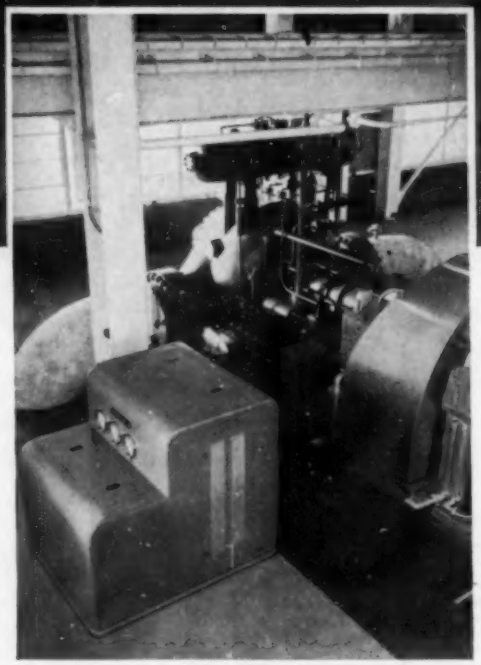
P_d/P_u	X
.10	.67
.15	.68
.20	.69
.25	.70
.30	.71
.35	.725
.40	.74
.45	.76
.50	.78
.55	.80
.60	.82
.65	.84
.70	.86
.75	.88
.80	.90
.85	.925
.90	.95
.95	.975
1.00	1.00

$15 Per Rule of Thumb

These formulae from the pages of engineers' own notebooks yield rough, but reasonably accurate answers for design, maintenance and supply questions. The Editors will pay $15 for your pet Rule of Thumb. Send your Rule of Thumb to Donald M. Taylor, Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1.

FOUR DE LAVAL CENTRIFUGAL COMPRESSORS *in Tescott, Kansas station of Northern Natural Gas*





For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M²SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M²SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 200,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

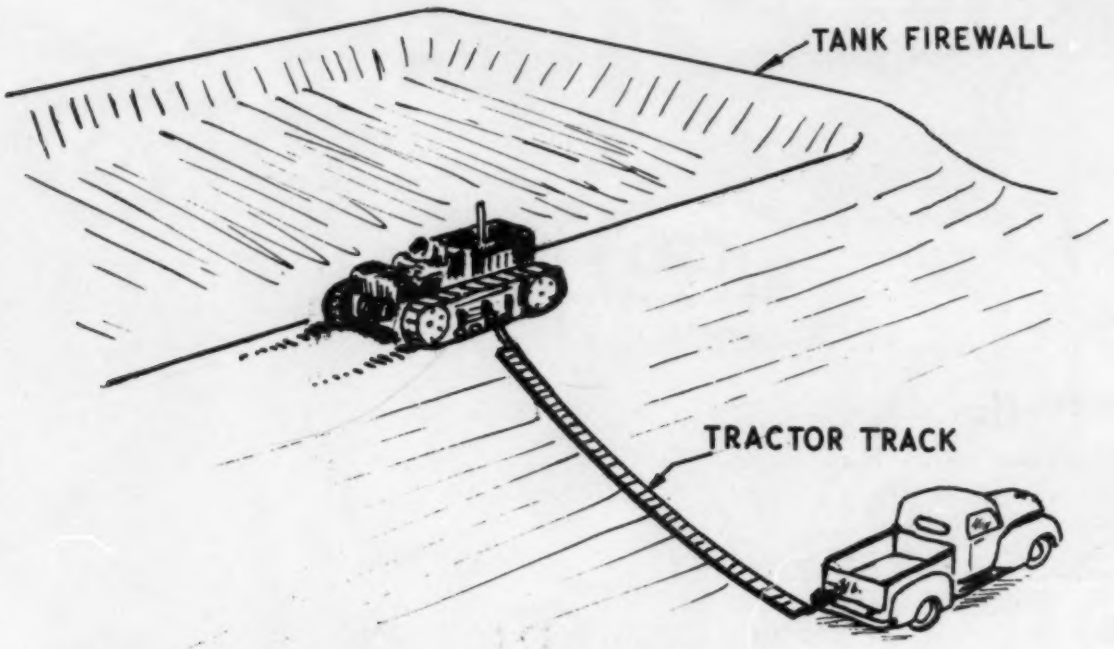
884 Nottingham Way, Trenton 2, New Jersey

DL308

How to do it

PIPE LINE HINTS

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, PIPE LINE INDUSTRY, P. O. Box 2608, Houston 1, Texas



Discarded Tractor Track Used to Smooth Firewall

Taking an idea from concrete finishers who often use belts to fine grade concrete, one contractor uses a tractor track to drag the side of a firewall. This saves a great deal of hand labor and gives a better job.

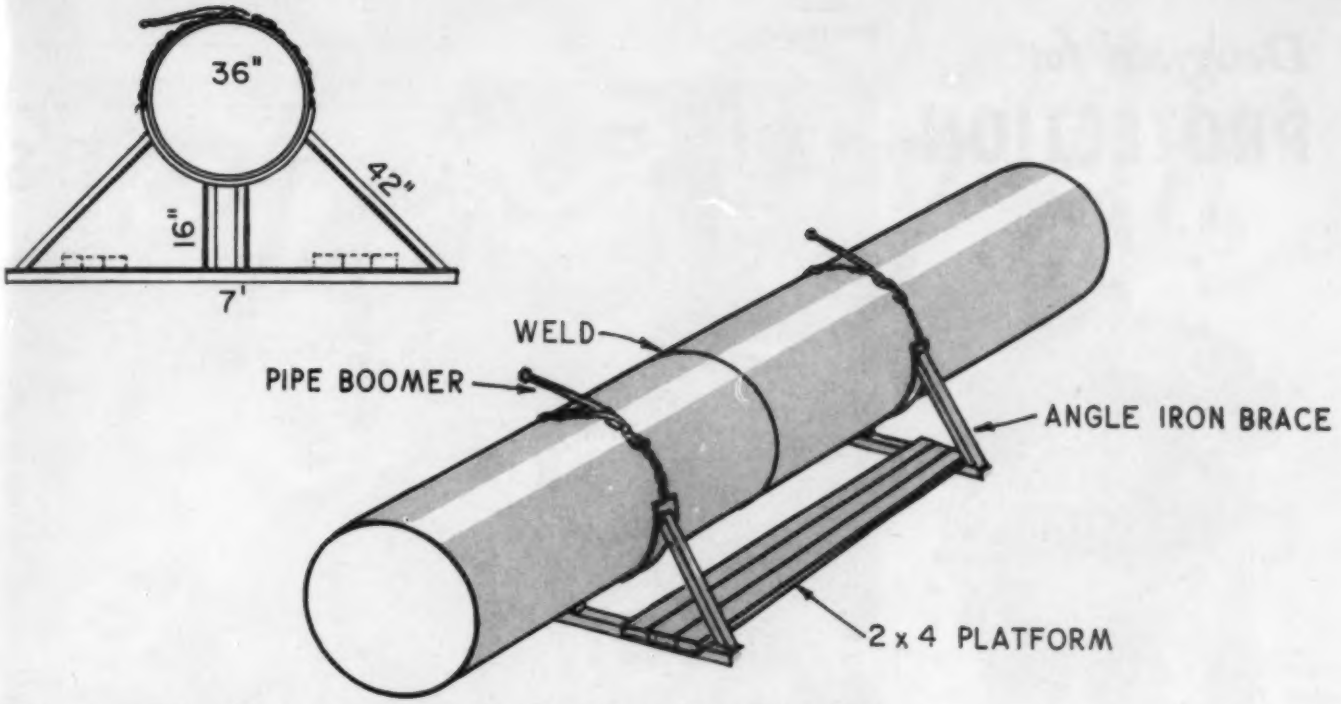
The top end of the track is hooked to the side of a tractor and the lower end is hooked on to a pickup truck. With the tractor leading, the two pull the track around the firewall a time or two. Then the tractor drives down the slope. A man with a shovel can obliviate the tractor tracks in short order—and the firewall is "polished."

Protect Tractor Engines On Very Steep Slopes

When operating tractors on extremely steep slopes, it is a good idea to take extra precautions to make sure top shaft bearings are lubricated.

If the tractor is going to be operated this way for long periods of time, add extra oil to the transmission to prolong bearing life. When extra lubricant is not readily available, get improved lubrication by maneuvering the tractor sideways every 500 to 1000 feet.

A little special care will cut down time and maintenance costs under these unusual working conditions.



Clamp Platform to Big Inch Pipe for Welders

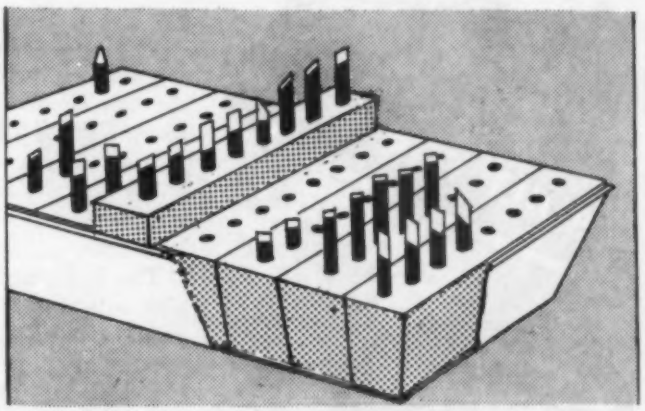
As pipe lines have become larger and larger, working on top of the pipe has become more and more of a problem for welders.

Recently, in laying a 36-inch line, one welding contractor devised the platform shown. The 2 by 4 platform is clamped to the pipe with two ordinary load binders or "boomers." The stand enables welders to easily reach any part of the pipe.

Use Baking Pan to Make Lathe Tool Bit Holder

To be sure that lathe tool bits are easy to find when needed, make an inexpensive holder from a "dime store" baking pan and a ¾-inch board. Saw the board the width of the pan, making enough sections to fill the pan when they are placed as shown.

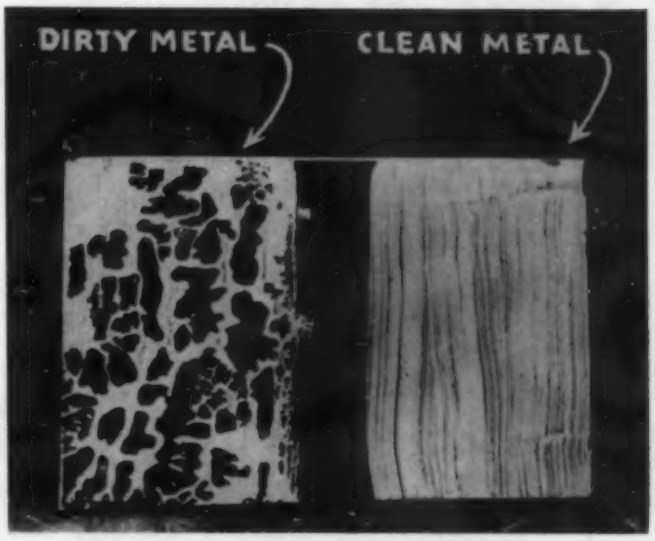
Drill holes in each board to hold the bits, in this case, eight in each section. Sections may be lifted out separately. Bits of particular type can be kept together in one section for convenient use.



Flux Often Indicates Surface Too Dirty to Braze Well

The left side of the photo shows how flux behaves on an oily steel surface; the section on the right had been cleaned thoroughly and degreased before applying flux. An attempt to braze the surface on the left would probably result in poor wetting of the metal and a mechanically weak and leaky joint. If flux wets poorly, the most economical thing to do is to clean and degrease before brazing.

To clean, first use a vapor degreaser or solvent. Then remove any oxide by pickling or by using an abrasive wheel or belt. After cleaning be careful, too, not to touch the joint faces. A greasy fingerprint can do as much damage as a patch of oil.



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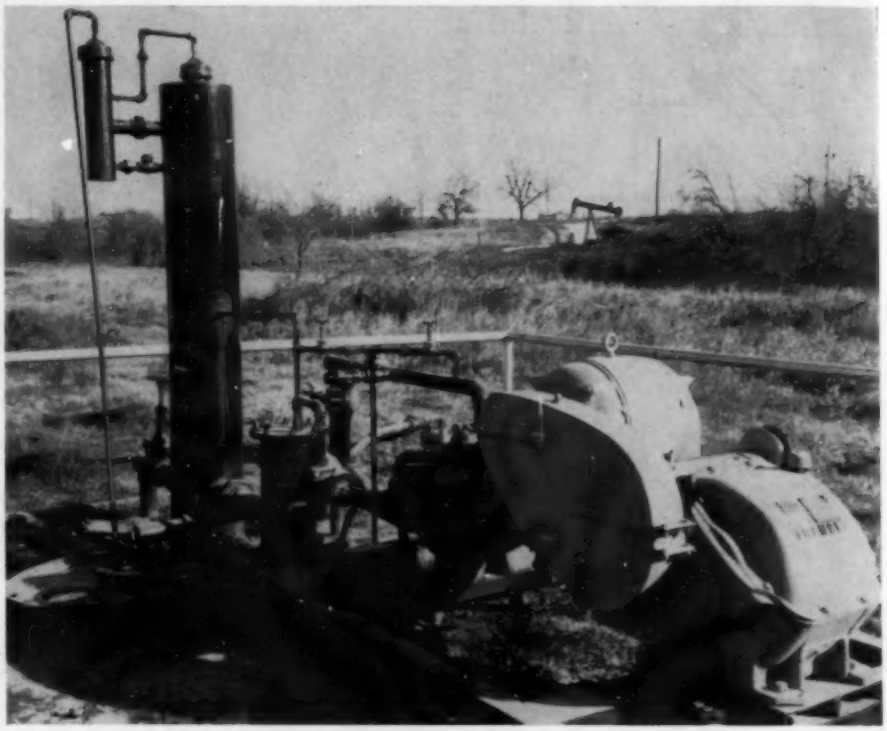

Traps Prevent Air from Entering Pump

Two traps placed on the field pump suction line will prevent any air from entering the pump. The first trap acts as a scrubber. Any air that is in the line will rise to the top and a float in the side chamber will keep the vessel from overflowing. A second trap, just downstream, is equipped with a float and a mercury switch which will shut off the electric motor when the oil level falls.

The large trap is made of 12-inch pipe with welded inlet and outlet connections a few inches from the bottom. Near the top, a two-inch nipple is welded on the side to support the float chamber. A check valve connection is welded just beneath to effectively drain the float chamber, yet not allow fluid to enter without first overflowing the large chamber. At the top, a three-inch connection swedged down to a half-inch allows the oil overflow to operate the float. When float shuts off the line leading out the top, any leakage runs back into the sump.

The second pot contains a strainer and a float in a side chamber which operates the cut-off switch. As long as the strainer chamber is full of oil, the switch is closed and the motor runs. When the oil level falls as a result of air in the line, the float drops, energizing a solenoid to cut off the motor.

Electric Motor on Pump Eliminates Extra Mounting

On pipe line stations where electric power is used, the electric motors can be placed in the middle of the pump so that no extra mounting or foundation is needed.

The motor is bolted to the frame of the pump and connected to the driving sheave by V-belts. The electric current comes beneath the ground in conduits and up through a riser to the motor. A cover can be made for the motor by splitting an old gas prover chamber. V-belts are protected by a short cover which entirely covers both sheaves.

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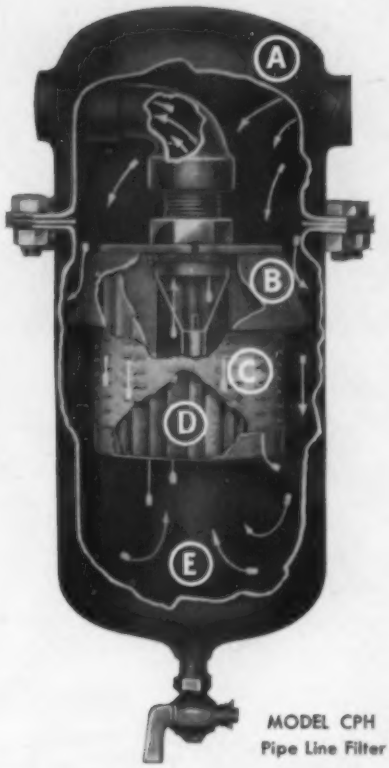

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Shop-Made Bucket Stand Aids Small Parts Washing

A tripod stand for holding a wash pail saves time and effort when washing small parts in solvent. In addition, the bucket and solvent are kept handy for the next job.

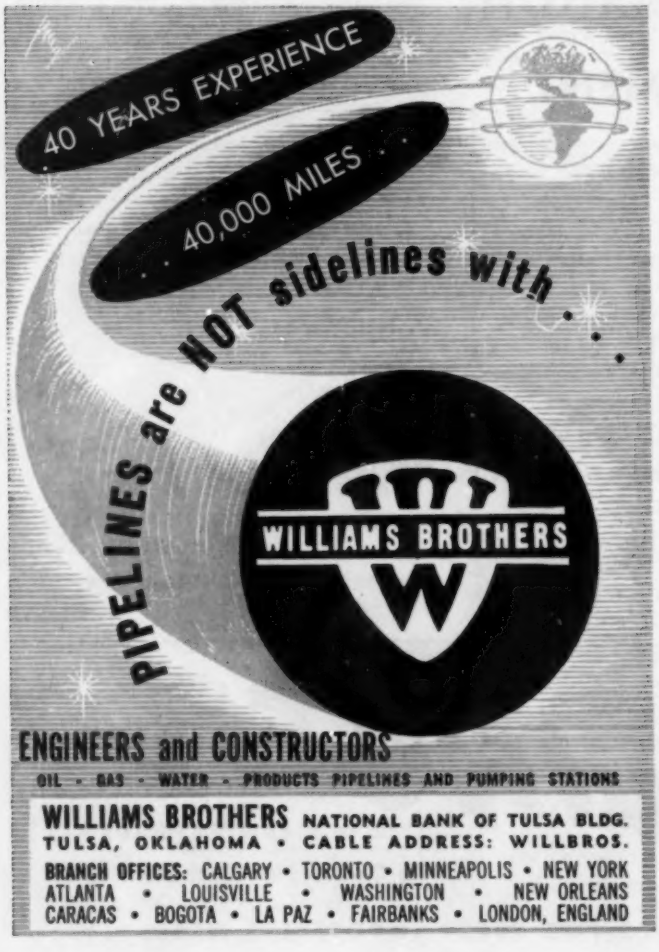
The stand is made from ⅝-inch sucker rod welded as shown. Three lengths of rod, bent to the proper size, hold the bucket. The larger ring should be sized to fit just beneath the rim; the second, to fit near the bottom. The third ring acts as a brace. Legs are cut to a length so that top of the pail is about 30 inches high.

Inside the bucket is a removable false bottom made from 1/16-inch tinner's metal. It allows dirt to settle out of the solvent. A lid cut from tinner's metal keeps solvent clean when not in use.

Metal Signal Flag on Tank Notifies Pipe Line Gager

A system of signals has been worked out between the lease pumper and the pipe line gager when it comes to running a tank of oil into the pipe line gathering system. By means of a flag made of sheet metal, the pumper can signal that a stock tank is full and ready to be run into the pipe line.

The system has worked to the satisfaction of both. The flag device was made from sheet metal and shaped like a flag, as shown. The flag staff is a short piece of sucker rod that fits into a section of 1½-inch pipe welded to the upright support on the walkway hand rail at the top of the stock tanks. Such a section of pipe is located adjacent to each tank. When that particular tank is full and ready to be run into the pipe line, the pumper merely sets the flag in place in front of the full tank. After the gager has emptied the tank, he removes the flag, and the pumper knows that the tank is ready for switching to take production again. The system is a simple one, and has saved a lot of time, steps and trouble for both the lease pumper and the pipe line gager.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Build Light Foot Bridge on Pipe Line

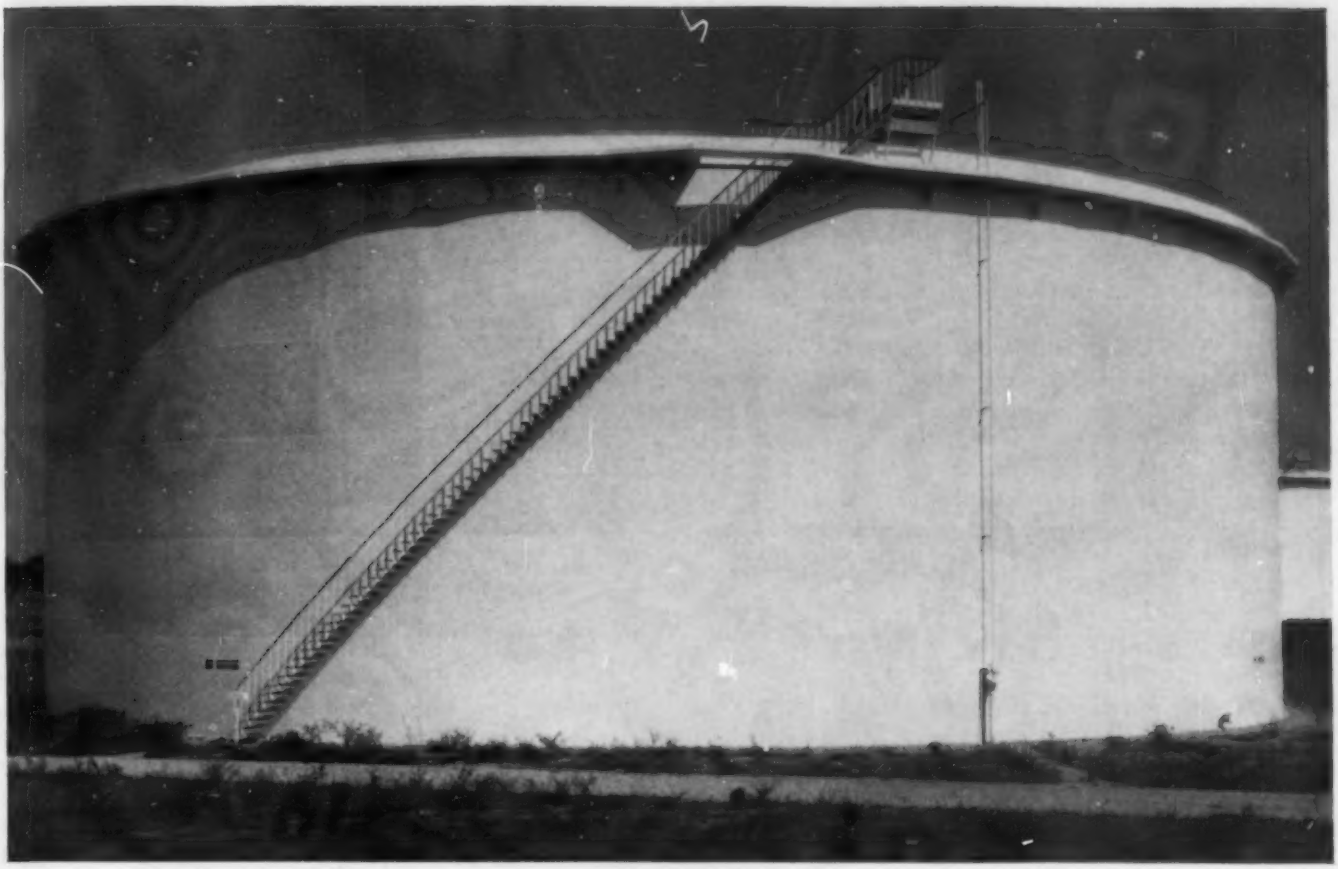
One pipe line company designed a light bridge so their chart changer could cross a ravine to a meter house. The 20-foot bridge was made up largely from pipe and pipe fittings and fastened to the exposed section of their low pressure 8-inch line.

A double U-bolt saddle was clamped to the pipe 30 inches out from each bank. To these, 1¼-inch couplings were welded and the screw pipe frame was made up as shown. Horizontal hand rails of one-inch diameter pipe were attached to the top of the risers. At the ends of the bridge, hand rails were turned downward and the ends were set in concrete on the bank.

Two 2-by-10 inch planks form the bridge floor or cat walk directly over the pipe line. Short wooden tee footings placed between the floor boards and the 8-inch pipe were nailed to planks to prevent sagging and springing of the walkway.

Old Tires Prevent Damage to Concrete

When necessary to move a heavy crawler tractor with cleated treads across a concrete road, lay old, discarded tires ahead of the treads to prevent damage to the concrete. The tractor can move on the tires without the treads nicking or chipping the surface of the road.



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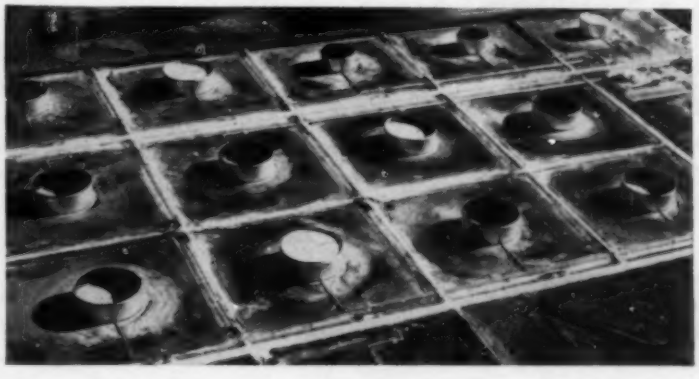
While the Graver Double-Deck Floating Roof Tank is the costliest of our three "floaters," it often proves least expensive in the long run.

Its unusual strength and structural stability make it appropriate wherever lots of snow and ice are encountered. The double-deck roof, consisting of top and bottom deck plate, is divided into liquid-tight compartments. Thus it is practically unsinkable. With the Graver Double-Deck Floating Roof Tank maintenance costs are held to a minimum.

Other popular Graver designs include the Center-Weighted Floating Roof Tank which is unusually stable. We offer also a pan-type floating roof...an economical design suitable to southern climates where snow and ice present no hazard.

Whatever your storage needs it will pay you to contact Graver. Consultation costs you nothing, and competent Conservation Engineers are ready to serve you.

GRAVER ... *a conservative design to fit every need*



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Pipe Line Men

IN THE NEWS

Ben R. Newbery of Dallas, director of purchases and materials for the Lone Star Gas Company, has received the 1955 Shipman Award from the National Association of Purchasing Agents for outstanding services to the purchasing field over an extended period. He began his career with Lone Star's purchasing department in 1915. He moved from Fort Worth to Dallas with the company in 1919 and was appointed purchasing agent, following a brief term as "acting" purchasing agent. He was appointed to his present position as director of purchases and materials in 1943.

R. T. Branch

T. C. Williams

Stone & Webster Engineering Corporation has announced that **Russell T. Branch** and **T. Cortlandt Williams** have been elected chairman of the board and president, respectively, of the corporation.

Branch, who has been president of the engineering corporation since 1945, has served in various capacities including construction manager and executive vice president since joining the company in 1912.

Williams joined Stone & Webster in 1923 and has had broad experience in the engineering and construction field. He was appointed construction manager in 1942 and elected executive vice president of the corporation in 1953. As president he will be responsible for the corporation's worldwide engineering and construction activities.

•

John P. Viglini, senior engineer in transmission engineering, has been appointed assistant chief engineer for the Transmission division of **Lone Star Gas Company** and **Lone Star Producing Company.** He joined Lone Star in 1929 as a draftsman and was assistant office engineer prior to being named senior engineer for his department.

•

Ralph N. Thomas, geologist and engineer for Inland Gas Corporation, since 1939, has joined the Measurement and Research staff of **Texas Gas Transmission Corporation** as geologist for underground storage.

In his new position, Thomas will conduct studies of the geology of the Texas Gas nine-state operating area to determine feasibility of developing additional natural gas storage fields.

ToPaz

has the answer to

CORROSION

WITH

- ✓ Holcombe Selenium Rectifiers
- ✓ Lion Asphalt Pipe Coatings
- ✓ Fiberglas & Asbestos Wraps
- ✓ Graphite Anodes
- ✓ Coke Breeze

Counteracting corrosion of underground pipes can mean tremendous savings for your company. As part of it's famous "one for all" service ToPaz distributes the complete Holcombe Company line of pipeline protection equipment and supplies.

You can trust ToPaz for high quality, dependable corrosion prevention equipment at all times. You can depend on ToPaz fast delivery and prompt, personal attention to your order. Contact ToPaz for all pipeline equipment and supplies. You'll get the job done faster with ToPaz helping you.

Topaz Offers Complete Engineering, Consulting, Testing, Inspecting and Internal Cleaning Services

AGENTS FOR:
T. D. WILLIAMSON, INC.
THE HOLCOMBE CO., INC.

Tod Pazdral
PIPELINE SPECIALTIES

ToPaz

2525 South Blvd. • Houston, Texas • Office Phone JA-2-1403

Tod Pazdral	Jack Pelkey	Richard Lee McHenry
F. A. (Jim) Ford	Sales & Service	Sales & Service
Consulting & Supervision	Atlanta	Dallas
Home Phone MA 3-5680		

GROVE SEAL "O" RING VALVES • TIPTON WELDING CLAMPS, HOOKS & DOLLIES • ALSTON PIPE CUTTING MACHINES • FLEETLINE PIPE SADDLES & REDUCERS • H & M CUTTING & BEVELING MACHINES • ANDERSON EQUIPMENT CO. HEAVY MACHINES • ORDER FROM TOD PAZDRAL

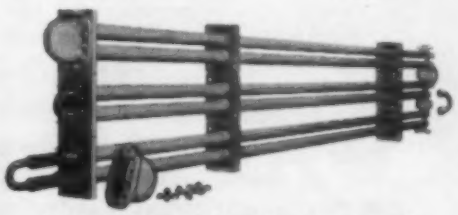
They're all repeat orders for G-R Twin G-Fin Sections

Re-orders — the ultimate proof of satisfactory service — run into the hundreds for many, many purchasers of G-R Twin G-Fin Sections.

Users have re-ordered and **continue to re-order** these units because of the uniformly top-notch performance of each successive installation. In many instances, they have re-ordered and **continue to re-order** to extend the application of these many-purpose heat exchangers to services throughout their plants. Customers all over the country have re-ordered year after year for ten, fifteen years and more, running up the astonishing total of more than 70,000 installed Twin G-Fin Sections during the course of the 25 years since Griscom-Russell originated this design of heat transfer apparatus.

Write for Bulletin 1400 describing the G-R Twin G-Fin Section in detail.

Sectional view of the G-R Twin G-Fin Section



Stack of G-R Twin G-Fin Sections partially dismantled to show ready accessibility of the longitudinally finned heat transfer elements

G-R HEAT TRANSFER APPARATUS

THE GRISCOM-RUSSELL CO.
MASSILLON, OHIO
A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

GR-347

Twin G-Fin Section

For more data on advertised products, use Readers' Service Cards, last page.

John M. Winters, Jr. has been elected president and treasurer of the **Transok Pipe Line Company,** recently organized in Tulsa and chartered by the state of Oklahoma. He is a member of the law firm of Conner, Winters, Randolph and Ballaine.

Other officers of the company include **Roger S. Randolph** and **Horace D. Ballaine,** vice presidents; **C. C. Killin,** vice president, secretary and assistant treasurer; **J. R. Ryan,** assistant secretary; and **P. H. Kuper,** controller.

The election of **George H. Neilson** as a vice president of the **Algonquin Gas Transmission Company** of Boston has been announced. He will be in charge of pipe line operation, gas measurement, dispatching, engineering and design, communication and construction. He has been serving as chief engineer of the company.

A veteran of 30 years experience in the natural gas industry, he was formerly general superintendent of production and transportation of the Equitable Gas Company of Pittsburgh.

John Talbot

George White

Tennessee Gas Transmission Company promotions of **John Talbot** to compressor superintendent and **George White** to assistant compressor superintendent have been announced.

Talbot, formerly assistant compressor superintendent, has more than 30 years experience in the gas and oil industry. He joined the company in 1943, and shortly was made superintendent of one of the firm's original compressor stations at Monroe, La. In 1945 he became a division superintendent, and three years later was promoted to assistant compressor superintendent. White has been an engineer in the compressor section of the company's Operating department since 1945.

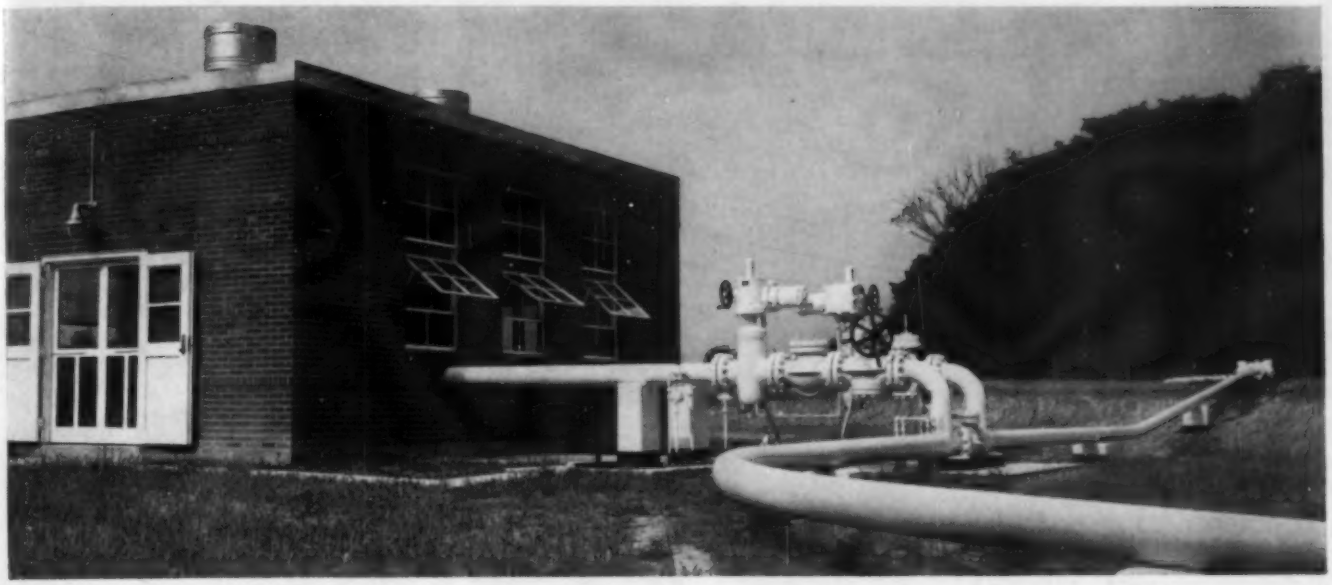
Wilton E. Scott has been appointed manager of exploration in the production division of Tennessee Gas.

From 1936 to 1938 he did surface geology for Standard Oil Company of New Jersey in Venezuela. Returning to this country, he joined Cities Service Oil Company and, in 1944, the Buffalo Oil Company. In 1954 he was elected a vice president of Buffalo Oil and Maljamar Oil and Gas Corporation, a Buffalo associate. He recently resigned from Buffalo to join Tennessee Gas, and has moved from Midland to Houston to assume his new duties.

•

Ida Belle Spinks, administrative secretary with **United Gas Corporation,** has become one of the first women to complete an Institute of Gas Technology course of study. Although IGT restricts its undergraduate and graduate classes to men, she recently received a Certificate of Accomplishment for having satisfactorily completed a home study course on "Natural Gas Production and Transmission." She was the only woman among 1081 enrollees in the course to date.

MORE THAN
12,000,000 FT.
of TK-2 PLASTIC
LINED PIPE
More than 3,000 miles of pipe have been lined with Tube-Kote plastics — enough for a "pipe line" to reach from Houston to Edmonton and farther!
EDMONTON
HOUSTON
Tube-Kote plastic linings are in service in more pipe and tubing than any other kind of linings known. One of the reasons is because at Tube-Kote, plastic lining consists of cleaning, inspection .. sandblasting, inspection .. application of Tube-Kote's special plastics, thermo-bonding each layer to the metal, inspection ... application of external "weathering paint" ... storing for shipment. It's a complete, assembly line process with every phase carefully controlled by Tube-Kote engineers.
Now, with new facilities — new pipe storage racks ... new spraying and baking equipment — Tube-Kote can process your orders almost twice as fast. Also, there's a big quantity price discount now in effect that may save you thousands of dollars.
Write today for information about TK-2 plastic linings and how they prevent corrosion and paraffin deposition. Details of new quantity price discount will also be sent to you.
Tube-Kote sand blasting equipment assures good bonding surface
TUBE-KOTE, INC.
P.O. BOX 20037, HOUSTON 25, TEXAS
TUBE-KOTE
Pioneers in plastics since 1939 ... manufacturers-extruders of plastic pipe for the oil industry. Factory-trained field engineers available for consultation in all principal oil areas.



This Illinois pumping station is controlled by a man in Radio City

When dialed, the pumping station automatically sends its meter readings via teletypewriter to the dispatcher in New York.

Shell Oil Company's automatic pipeline pumping station in Dennison, Ill., is supervised and controlled over Bell System lines from an ordinary telephone dial in New York City—more than 800 miles distant!

For meter readings, Shell's dispatcher in New York's Radio City dials a number. Back on the teletypewriter from the Dennison station come suction and discharge pressures and motor current readings.

He dials other numbers to start or stop the pump, open or close valves or to summon an attendant.

This remote-control system keeps the pipeline—which carries 22 different finished petroleum products—operating smoothly from one central location. Dennison is only one of four similarly controlled pumping stations on the line.

Using Bell System communications, you get the benefit of new developments without tieing up capital.

We supply the pipeline industry with reliable private line telephone and teletypewriter service, maintain mobile radio facilities and provide channels for telemetering and supervisory control.

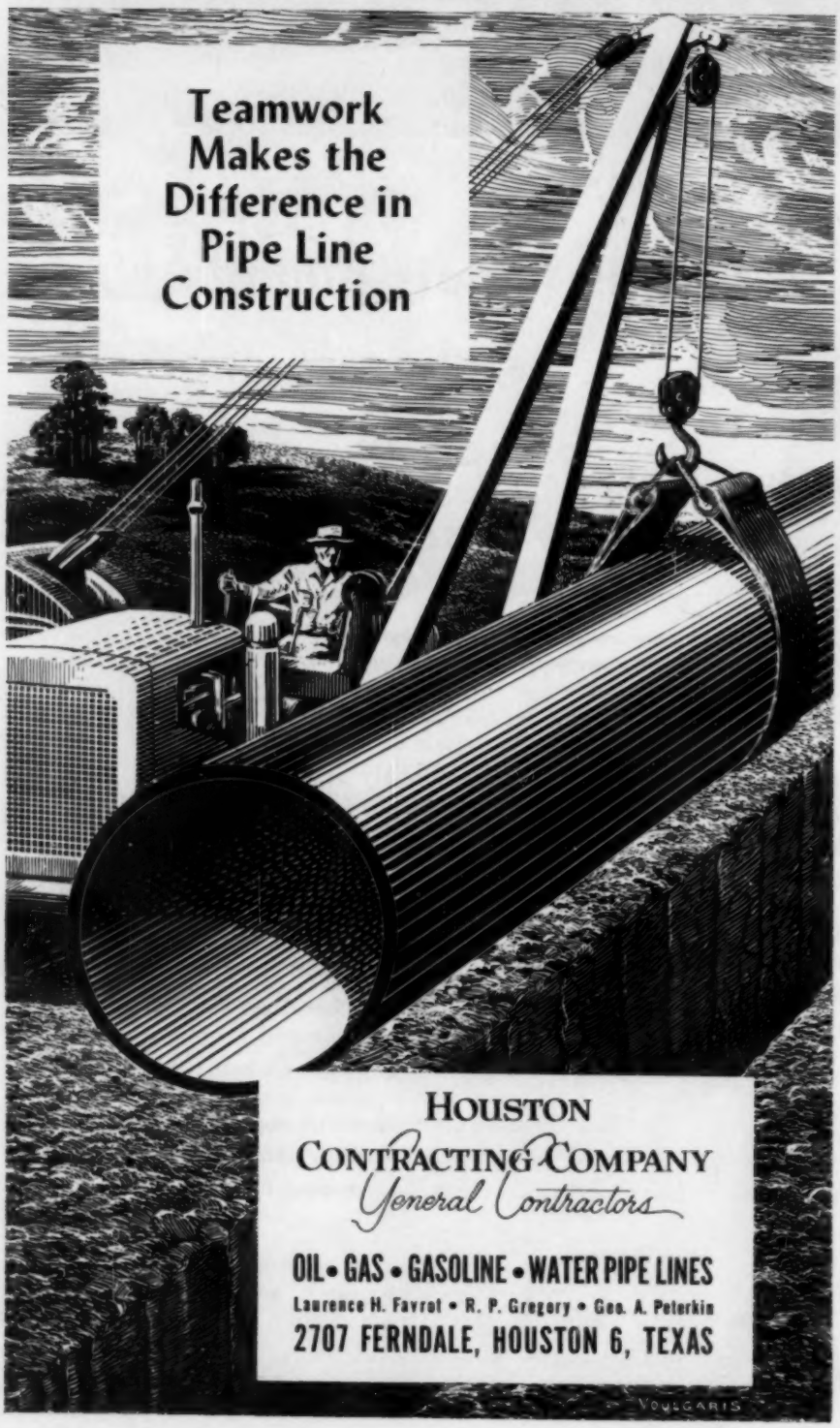
Bell System communications engineers will be glad to survey your communications needs without charge. Call your Bell Telephone representative today.

BELL TELEPHONE SYSTEM

TELEPHONE TELETYPEWRITER MOBILE RADIO TELEMETERING AND REMOTE CONTROL CHANNELS

Planned Short Course

Chairmen of the general committee of the 1955 Southeastern Gas Measurement Short Course held recently at the University of Oklahoma, include: (sitting, left to right) K. R. Tibbetts, Warren Petroleum Corporation; W. H. Carson, University of Oklahoma; and Kate A. Niblack, Oklahoma Utilities Association. Standing, left to right, are R. B. Fleske, Cities Service Gas Company; R. F. Nowlin, United Gas Corporation; M. D. Gilbert, Rockwell Manufacturing Company; Roland O. Cox, Lone Star Gas Company; and R. R. McCafferty, Pioneer Natural Gas Company.



At **Magnolia Pipe Line Company, L. A. Foy,** former chief gager in the Western division, has been promoted to district superintendent of the West Texas district with headquarters at Midland. He succeeds **Rey W. Stewart** who has gone to Iran on a loan basis to Socony Mobil as pipe line operating engineer.

Clyde R. Smith, gager foreman at Snyder, Texas, has been promoted to chief gager of the Western division; **A. G. Schwarz,** chief delivery gager at Midland, has been advanced to gager foreman at Sweetwater, Texas; and **R. L. Smith** has been moved to Snyder as gager foreman. He was formerly at Sweetwater. **John R. Whorton,** field gager in the North Basin district, has been promoted to chief delivery gager at Midland.

R. L. Phillips, assistant superintendent of the West Texas district, has been moved to Brownfield, Texas, as assistant district superintendent of the North Basin district; **F. G. White,** district superintendent of the North Basin district, has been promoted to assistant division superintendent of the Northern division; **A. W. Butler,** assistant district superintendent of the North Basin district, has been promoted to district superintendent of the same district, and **M. E. Bay,** district superintendent of the North Texas district, has been moved to Corsicana as district superintendent of the Dallas district, replacing **C. E. Still,** who retired.

J. R. Dean, assistant district superintendent of the Houston-Beaumont district, has been promoted to district superintendent of the North Texas district, and **W. M. Harris,** assistant district superintendent of the Dallas district, has been transferred to Snyder as assistant district superintendent of the West Texas district.

For more data on advertised products, use Readers' Service Cards, last page.

Fight Corrosion

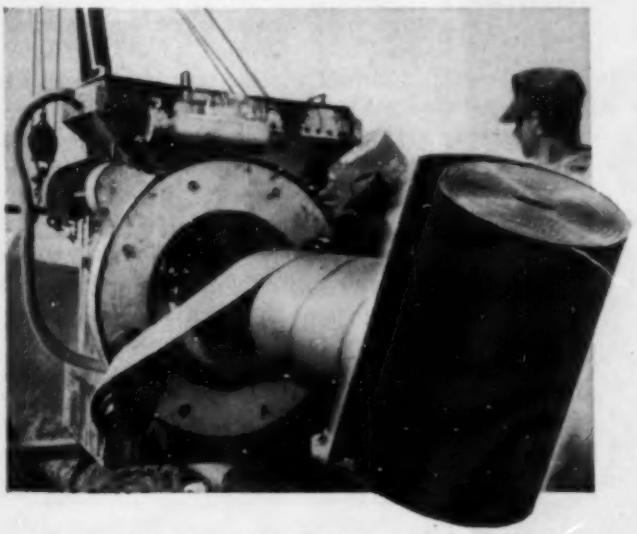
with these

Johns-Manville Pipe Protection Materials

...cut maintenance expense increase pipe life

TRANSHIELD Asbestos Felt—

This newly developed low cost pipe line protecting wrapper is designed for average soil conditions. It is reinforced with continuous glass yarns, parallel spaced on ¼" centers to give tear-free application strength. Made of coal-tar saturated asbestos, it acts as a continuous barrier to shield pipe line enamels from earth loads and soil stresses.



15-LB. ASBESTOS Pipe Line Felt—

A heavy-duty material particularly suitable for severe soil conditions or where a heavier material than J-M Transhield is desired. Provides long life, toughness, flexibility, resistance to rot, decay, cracking, and impact. J-M 15-lb. Asbestos Felt now protects more than 100,000 miles of oil and gas pipe lines. Widths 2" to 36". Rolls any length desired.

TRANTEX® Polyvinyl Tape—

A widely used coating where ease of application is important . . . over field welded joints of mill-wrapped pipe . . . for rush coating needs. Pressure-sensitive . . . sticks to pipe on contact, forming a firm stable bond. Can be cold-applied by hand or with simple wrapping machines. In rocky soils, an outer wrap of J-M Transhield or J-M 15-lb. Asbestos Pipe Line Felt is recommended.

For further information about Johns-Manville Products for Pipe Line Protection, write to Johns-Manville, Box 60, New York 16, N. Y.; in Canada, 199 Bay St., Toronto I, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville **PRODUCTS FOR PIPELINE PROTECTION**

For more data on advertised products, use Readers' Service Cards, last page.

R. V. Lahr has been named to head the newly-created Field Operations department of **Shell Pipe Line Corporation.** The department will be responsible for interpretation of operating statistics, development of methods leading to operating economics, negotiation of utility agreements, and administration of auto equipment and aircraft use policies.

Lahr has been with Shell Pipe Line for 22 years, with service in all areas in which the company operates. His past experience includes duties as an electrical engineer and corrosion engineer, assistant area manager and area manager, and most recently as assistant to vice president.

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Cary M. Abney, Marshall, Texas, lawyer and business man, and **W. T. Murphy, Jr.,** Texarkana business man, have been elected to the board of directors of **Arkansas Louisiana Gas Company.** With their election, nine of the board's 11 members are residents of Arkansas, Louisiana and Texas, the area which the company serves.

when the moon has pipelines
they'll be cleaned with . . .
WmSON WCK-12 PIGS
They're "out of this world" already — according to pipeliners who use them.
THEY'RE NOTED FOR:
• SIMPLICITY OF DESIGN
• DEPENDABILITY OF PERFORMANCE
in all kinds of lines 6" through 14" sizes
T.D. Williamson, Inc.
THE PIG WITH THE POKE
CLEANS PIPE LINES
P. O. BOX 4038
TULSA 9, OKLAHOMA

REPRESENTATIVES (with their feet firmly on the earth)

Houston • Pittsburgh • Kenilworth, N. J. • Amarillo • Casper • Provo, Utah • Joliet, Illinois
Los Angeles • San Francisco • Bartlesville, Okla. • Edmonton • London, Ontario • Calgary
Buenos Aires • Durban, Natal, South Africa

Greets Indian Prince

When Sammy Collins met the Maharaj Kumar Shivendra Singhi, heir apparent to the throne of the Indian state of Palitana, at the Houston International Airport recently, an old friendship was renewed. While in India constructing a pipe line, Collins, owner of Collins Construction Company, and his family lived in the 127-room palace of the Maharajah of Palitana. Accompanying the prince on his visit to the Collins' at Port Lavaca, Texas, is the Princess Seeta Kumari.

Wallace W. Mitchell has been advanced to the newly-created position of general superintendent of **Tide Water Associated Oil Company's** Western Pipe Line department. He will be in charge of the company's 789 miles of oil lines in the San Joaquin Valley and the Los Angeles areas of California, as well as four California marine terminals south of San Francisco.

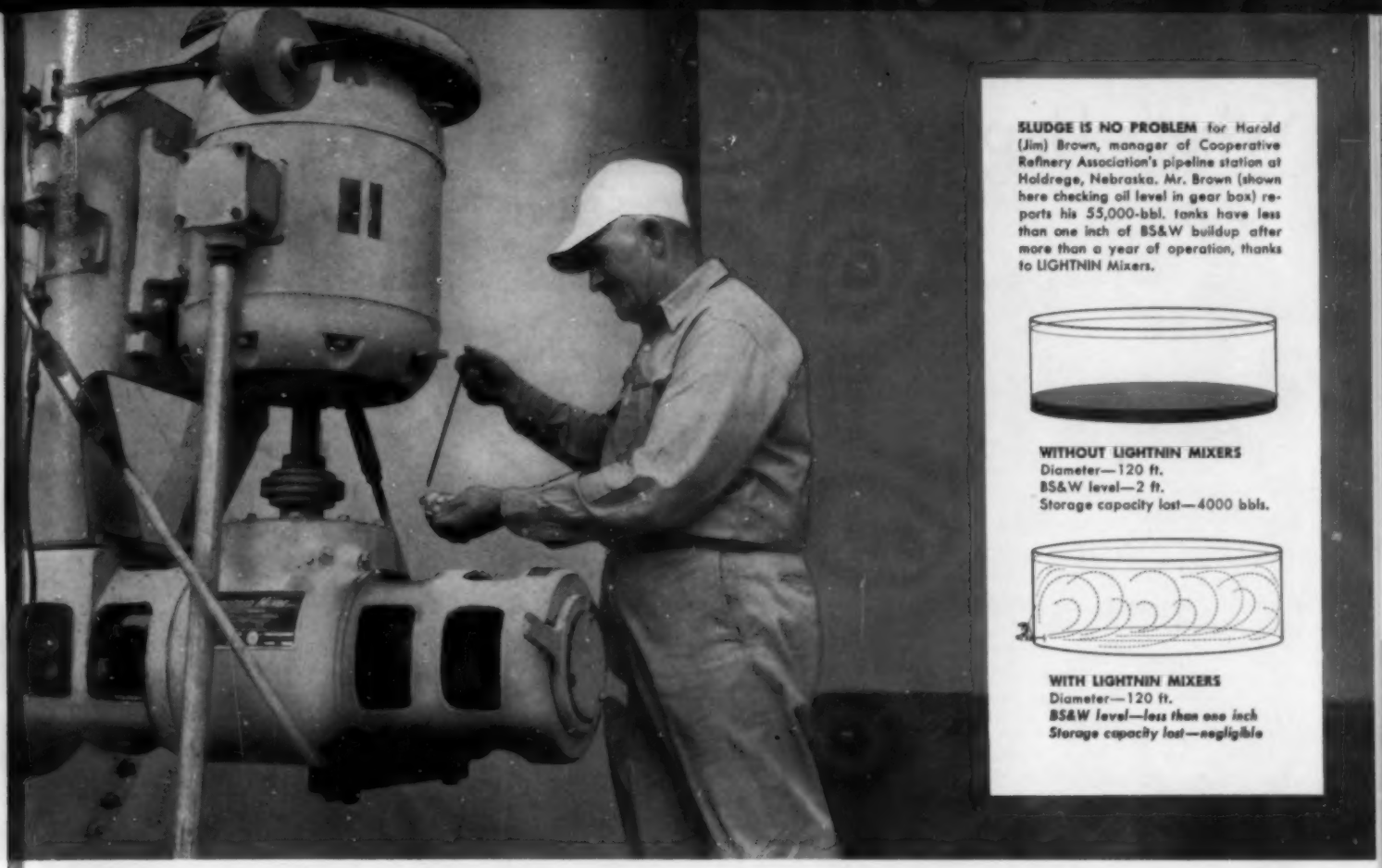
Duane W. Heeren will be chief engineer of the pipe line department. He has been assistant superintendent of the San Joaquin Valley Pipe Line System.

Frank E. Coyle continues as superintendent of the Southern California district of the department, and **William S. Davidson, Jr.** has been appointed superintendent of the San Joaquin Valley district. He will make his headquarters at Coalinga, Calif.

•

Promotion of three employes has been announced by **Texas Gas Transmission Corporation.**

Royce Cox, former assistant to the manager of purchasing, has been named assistant purchasing agent in charge of purchasing materials for compressor station operations and construction. **B. L. Cooper,** former assistant expediter, has been promoted to expediter. **Robert T. Robinson,** former supervisor of construction accounting, has been promoted to assistant manager of plant accounting in charge of construction and plant ledgers.



SLUDGE IS NO PROBLEM for Harold (Jim) Brown, manager of Cooperative Refinery Association's pipeline station at Holdrege, Nebraska. Mr. Brown (shown here checking oil level in gear box) reports his 55,000-bbl. tanks have less than one inch of BS&W buildup after more than a year of operation, thanks to LIGHTNIN Mixers.

WITHOUT LIGHTNIN MIXERS
Diameter—120 ft.
BS&W level—2 ft.
Storage capacity lost—4000 bbls.

WITH LIGHTNIN MIXERS
Diameter—120 ft.
BS&W level—less than one inch
Storage capacity lost—negligible

Is sludge hogging your tank capacity?

Cooperative Refinery Association cleans tanks by flipping a switch. So can you.

Sludge is a tank hog. It eats up valuable tank capacity you badly need for crude. It's a messy tenant, too, and cleaning up after it is a costly, dirty job.

Rid your tanks of sludge, and you add as much as 12% more capacity to your pipeline stations.

Cooperative Refinery Association brings crude oil from Wyoming to its pipeline station at Holdrege, Nebraska, stores it in two 55,000-bbl. tanks. When the crude moves on to the refinery at Phillipsburg, it leaves a minimum of BS&W in the tanks. In more than a year of operation, scarcely an inch of sludge has accumulated in either tank.

Simple method pays off

Secret? Cooperative Refinery Association equipped each tank with a LIGHTNIN Side Entering Mixer. When temperature falls below 70°, these mixers go to work for about four hours a day. They keep bottoms stirred, prevent oil from congealing. When the oil moves on, each tank is ready to take on a new supply—without cleaning—and at full capacity.

LIGHTNIN Mixers are keeping storage tanks free of sludge at many pipeline stations, increasing storage capacity, eliminating downtime for cleaning, making every barrel in every tank merchantable crude oil.

Here's why you can't lose

You take no risk when you order a LIGHTNIN. Every one is unconditionally guaranteed to perform its job—or your money back.

Learn how LIGHTNINs can solve your sludge problems, make your tanks work harder, cut your costs. Call in your LIGHTNIN representative, or write us today.

Lightnin® Mixers

MIXCO fluid mixing specialists

Get these helpful facts on BS&W control and LIGHTNIN Mixers. Check, tear out and mail to us today with name and company address. Free—no obligation.

- ☐ B-503 Illustrated bulletin on BS&W control
- ☐ B-104 20-page catalog fully describing LIGHTNIN Side Entering Mixers
- ☐ B-107 Mixing Data Sheet
- ☐ B-110 Condensed Catalog describing LIGHTNIN Mixers of all types
- ☐ B-111 Bulletin describing LIGHTNIN rotary mechanical seals for extra-low-cost mixing

MIXING EQUIPMENT Co., Inc., 196-3 Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Avenue, Toronto 10, Ont.

What's Happening

AMONG SERVICE AND SUPPLY MEN

Paul C. Kreuch

Eugene F. Foubert

Rockwell Manufacturing Company Elects Two Vice Presidents

Paul C. Kreuch, assistant to the vice president in charge of Rockwell Manufacturing Company's Meter and Valve division, recently was named a vice president in that division. Eugene F. Foubert, manager of industrial relations for the company, was named vice president—industrial relations.

Kreuch joined Rockwell in 1930 as a sales engineer. Prior to this, he had spent seven years in the gas industry, including three years as chief engineer of Missouri Public Service Company.

Foubert joined Rockwell in 1941 as personnel manager of the Oakland, Calif., plant. In 1945, he was named manager of industrial relations, and was transferred to Pittsburgh in 1947.

Eastman Chemical Releases Plastic Pipe Line Movie

Eastman Chemical Products, Inc., recently has completed a sound-color film, "Plastic Pipe Lines" which illustrates use of Tenite Butyrate pipe to conduct various products. Installations shown include a pipe line for conduction of corrosive water, a reticulation sprinkler system, gas mains and house service lines for conduction of natural gas, and the first cross-country plastic pipe line, nine miles long, used to deliver oil from storage tanks near oils wells to the railroad shipping point.

Zwart Joins Marlow Pumps As Supervisor of Sales

Marlow Pumps, division of Bell & Gossett Company, has placed petroleum pump sales under the supervision of Herman C. Zwart, who's first position was as a test engineer in Worthington Corporation's Research and Development department. He also was job engineer on power and utilities for Caltex and executive officer for a pipe line company in Korea.

Herman C. Zwart

He recently completed an intensive training program at Marlow's main plant in Ridgewood, N. J.

Youngstown Begins Construction On New Tin Mill in Indiana

Construction of The Youngstown Sheet and Tube Company's new tin mill facilities at Indiana Harbor is underway. Production of the mill will double the capacity of present electrolytic facilities.

The new mill will consist of seven buildings to be constructed on 88 acres southwest of Marktown, a subdivision of East Chicago. Facilities will include a cleaning and annealing building, temper mill and coil storage building, preparation line building, electrolytic tinning line building, three shear lines, an assorting room, a warehouse and shipping building.

Tube Turns Names Harrington To Sales Development Staff

Edward F. Harrington has joined the staff of the Sales Development department of Tube Turns, a division of National Cylinder Gas Company.

E. F. Harrington

Formerly a sales engineer with Worthington Corporation and International Supply Company, Harrington joined Tube Turn's Product Engineering and Research department in 1954. Jack D. Tolliver is manager of the Sales Development department.

Harlan C. McKay Company To Handle Clark Automotive Line

Harlan C. McKay Company has been appointed to sell and service Clark Equipment Company's automotive line of axles, transmissions, torque converters and packaged power trains in Idaho, Oregon, Washington, British Columbia and Alaska.

Harlan C. McKay, president of the newly-appointed distributorship, has long been associated with the sales of engines and associated equipment to trucking and machinery manufacturers and to companies in the construction, logging, transportation and other industries in the Pacific Northwest. Prior to opening his business, he was northwest regional sales manager for the Buda Company and sales manager for Cummins Diesel Sales, Inc.

Allis-Chalmers Appoints Yost Vice President, Staff Operations

Appointment of William A. Yost, Jr. to the new post of vice president, staff operations, Allis-Chalmers Manufacturing Company, has been announced. He will direct activities in industrial relations, public relations, legal, purchasing, comptroller and research divisions.

Previously, Yost was vice president, general machinery division, a position he has held since 1951. He joined Allis-Chalmers in 1943 as manager of the marine division, steam turbine department, after being employed by Elliott Company.

Hughes to Be in Charge Of Reilly Dallas Office

Henry D. Hughes has been placed in charge of the Reilly Tar & Chemical Corporation sales office in Dallas, Texas. He has been engaged in the water and sewage construction business and has been associated with the Farquar Company. Prior to joining Reilly, he was managing his own oil and gas producing and operating organization. Hughes will have his headquarters in the Reilly offices at 520 Park Avenue, Dallas.

Henry D. Hughes

New Bucyrus-Erie Distributor Appointed for Saskatchewan

R. J. Fyfe Equipment Limited, Regina, Saskatchewan, Canada, has been appointed Bucyrus-Erie distributor for the entire province of Saskatchewan.

The new distributor offers sales and service on the Bucyrus-Erie line of ⅜- to 4-cubic yard convertible excavators and cranes, including the Canadian-built ¾-yard Model 22-B; 2½- to 8-yard Ward Leonard electric shovels; walking draglines with diesel or electric power, and 160-ton and 250-ton railroad cranes. The line also includes the 15-ton and 25-ton transit cranes, the truck-mounted, all-hydraulic Hydrocrane and Hydrohoe, Red Arch dragline buckets, and blast hole drills and bit dressers, including rotary drills.

Complete equipment servicing facilities will be maintained at the distributor's plant at Regina. A branch office is located at Saskatoon.

Blough Succeeds Fairless As U. S. Steel Board Chairman

Roger M. Blough has succeeded Benjamin F. Fairless as chairman of the board and chief executive officer of United States Steel Corporation. Fairless will continue as a member of the board of directors and the finance committee of the corporation. He also has been appointed chairman of the board's newly-formed Executive Advisory committee.

Clifford F. Hood, president of the corporation, has been reelected to office and designated chief administrative officer. John S. Tennant, who became associate general counsel of the corporation in January, has been named general counsel.

In 1952, Fairless succeeded Irving S. Olds as chairman of the board and was named chief executive officer of the corporation. At that time, Blough became vice chairman of the board. In 1953, he was elected general counsel. Fairless was elected president in 1938.

Blough was appointed general solicitor in charge of all legal matters for U. S. Steel Corporation of Delaware in 1942. In 1951 he became executive vice president-law and secretary, and a director of United States Steel Company.

Algeria
Angola
Aden
Alaska
Australia
Africa
Aruba
Brazil
Bahrein
Burma
Belgium
Ceylon
Canary Islands
Channel Islands
Cuba
Canada
Canal Zone
Columbia
Chile
Curacao
Cyprus
Denmark
Egypt
England & Wales
Gold Coast
Germany
Hawaiian Islands
India
Indonesia
Iraq
Italy
Iceland
Ireland
Japan
Labrador
Mozambique
Malaya
Mexico
Nigeria
Netherlands
New Zealand
North Rhodesia
Peru
Philippine Islands
Puerto Rico
Qatar
South Africa
South Rhodesia
Saudi Arabia
Syria
Sumatra
Scotland
Trinidad
Trieste
Uruguay
Venezuela
West Indies

Confidence cannot be bought over the counter. It must be earned through years of satisfactory experience. Confidence dearly earned is a manufacturer's most valuable asset. Confidence is the basis upon which the major oil producers buy equipment to ship to far away places. Throughout the world, where oil is produced, refined, stored or transported—there you will find S&J vapor conservation, tank safety, and automatic gaging equipment.

The equipment for use in the Sterling Areas is made in England by Whessoe, Ltd. That for use in the Dollar Areas is made in the United States by Shand & Jurs Co. Whether you BUY BRITISH or BUY AMERICAN, you get identical equipment, made from the same drawings—to the same specifications. Whether you deal in Pounds or Dollars, whether you figure in inches or centimeters—CONFIDENCE means the same thing in every language—any place on earth. That's why, where there's oil, there's S&J.

Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave

HOUSTON
M & M Bldg

TULSA
Thompson Bldg

CHICAGO
10409 S. Western Ave

LOS ANGELES
714 W. Olympic Blvd

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St. W
TORONTO: Lytle Engineering Specialties, Ltd., 69 Eglington East
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London S. W. 1
Whessoe, Ltd., Works: Darlington, County Durham

U. S. Steel's Oilwell Division Announces Staff Appointments

In U.S. Steel's Oil Well Supply division, Joseph Harry Young has been appointed field representative at Virden, Manitoba, Canada; John S. Purvis has joined the Gulf Coast area organization as field representative at the Brookhaven, Miss., store; James Anthony Groves has been named field representative at Swift Current, Saskatchewan, Canada; and R. P. Mitchell has been made field representative at Albany, Texas.

Recent transfers in the division include Elmer E. Stanley, field representative at Duncan, Okla., moved to Healdton; and William H. Beasley, field representative at Beaumont, Texas, moved to Harvey, La.

Arthur Bernard Stonehouse has been promoted from storeman at Ventura, Calif., to field representative at Castaic Junction, Calif.; Calvin Reed McAffee has been appointed manager of the division's store at Huntington Beach, Calif.; and Victor H. Blott has been named store manager at Victoria, Texas.

Fisher Governor Acquires Thermo Instruments Company

Fisher Governor Company has acquired the assets of Thermo Instruments Company, Belmont, Calif., manufacturers of capacitance probe type liquid level measurement instruments. D. M. Comb, former president of Thermo, is now associated with Fisher Governor Company in Marshalltown.

CLEANING & PRIMING MACHINES

Line-Traveling Over-the-Ditch or Stationary Yard and Railhead Types

Dependable machines developed through years of actual experience in serving the Pipeline Industry. Machines for every job and condition. For pipe sizes from 2" to 36". Outstanding is Perrault's Model ER machine with counter-rotating heads which cleans with any combination of knives, brushes or cutters from both directions at once. The counter-rotation reduces torque on pipe to a minimum, making operation and cradling easy. Call Perrault for a demonstration and be convinced it is best for your jobs.

ALSO: Coating and Wrapping Machines — line traveling or stationary. Tar-Heating Kettles, Patch-Pots, Burners and Accessories. Glass Pipe Wrap, Asbestos Felt Wrap, Kraft Wrap, and Rock Shield.

•

AND: Pneumatic-Tired Lowering-In Cradles, Adjustable Pipe Cradles, Five-Roller Cradles, Tongs, Belts, Slings, Hooks, Line-up Clamps. Hand Tools. Materials, Supplies and Equipment of every sort.

PERRAULT Equipment COMPANY

W. O. DIXON, Sole Owner

TELEPHONE 5-1103 • 1130 NORTH BOSTON • TULSA 6, OKLAHOMA

EXPORT OFFICE: SUITE 1655, 45 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Board Chairman, Vice Presidents Elected by White Motor Company

Directors of The White Motor Company have announced election of Robert F. Black to the newly-created position of chairman of the board and his reelection as president and chief executive officer of the company. Vice presidents J. N. Bauman, V. W. Fries and E. S. Reddig have been named executive vice presidents.

Robert F. Black

The executive vice presidents, together with Black, constitute the Operating Committee. In addition, Bauman, previously vice president of sales, will head the White Truck division. Fries, formerly vice president of production, will coordinate manufacturing and distribution of current and new products produced in all White plants. Reddig, vice president of finance, will be chief administrative officer of the company.

Black is concluding his twentieth year as president of the firm. He was first elected in 1935. All three of the newly-elected executive vice presidents were made members of the board of directors in 1953.

McAfee Named Manager Of New J&L Canadian Store

A store was opened in Estevan, Saskatchewan, by the Jones & Laughlin Supply division recently—the sixth J&L supply store in Canada. The new store will serve such southeastern Saskatchewan fields as Midale, Frobisher, Alida, Steelman, Ratcliffe and Lampman, and the Pierson field in Manitoba.

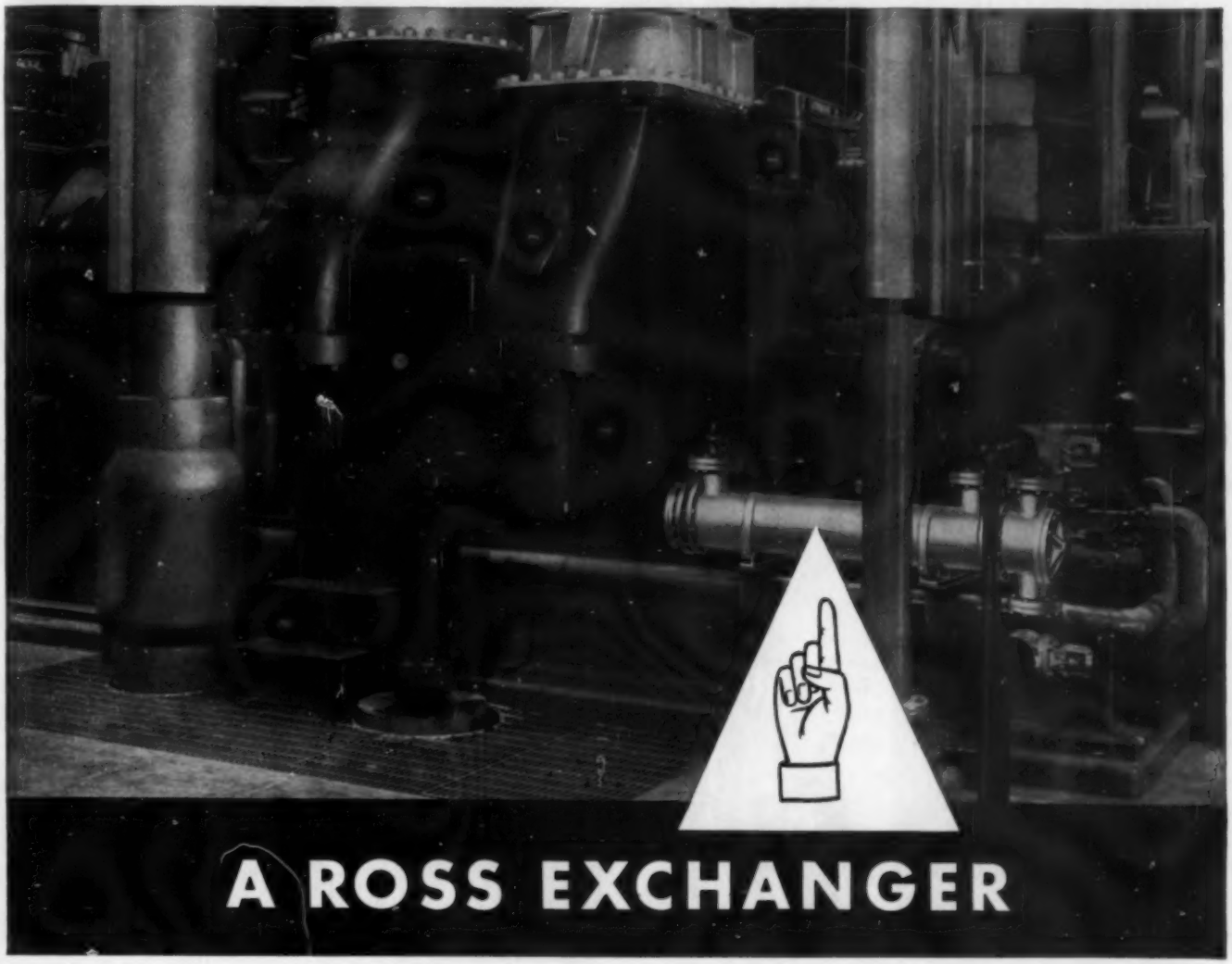
Local store manager will be M. D. McAfee, assisted by salesman R. D. Spenst and storeman Ronald C. Kellington. H. L. Wilkins, manager of J&L Supply division operations in Canada, will supervise the store. H. C. King, from the sales office in Regina, will assist in sales promotion in the Estevan area.

The store will specialize in sale and maintenance of pumping equipment.

PIPE LINE INDUSTRY

"Could you wait a few minutes? One of the fellows is developing film of this project."

For close control of lube oil temperature in this Ingersoll-Rand Turbo-Blower



Designed for wide range performance in gas booster service, this Ingersoll-Rand Turbo-Blower was installed by the Pacific Gas and Electric Company to meet increasing peak loads in the San Francisco area.

Rated at 30,000 cfm, the four-stage blower is driven by a 2,395 hp I-R Turbine at 4500 rpm. Controlling the lube oil temperature is a Ross Type CP Exchanger. Overheating is most dependably prevented.

"We never have trouble with Ross units . . . the fact that they are more or less standard on certain of our lines means they are entirely satisfactory," states Ingersoll-Rand.

Regularly selected for their top-rated thermal performance, Ross Exchangers are used extensively in the petroleum, gas and chemical industries on numerous types and makes of prime equipment: engines, compressors, speed increasers, centrifugal pumps, transformers and hydraulic equipment, to mention a few.

Assembled from mass produced parts and sub-assemblies to fully standardized, pre-engineered designs, Ross Type CP Exchangers are promptly available to meet most requirements. For detailed information, request Bulletin 2.1K1.

KEWANEE-ROSS CORPORATION

DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION

1450 WEST AVENUE • BUFFALO 13, N. Y.

In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

For more data on advertised products, use Readers' Service Cards, last page.

Mack Truck's Oldest Employe Retires After 53 Years

The oldest employe in the truck manufacturing industry in years of service, Frank A. Pampinella of Brooklyn, has retired after 53 years with Mack Trucks, Inc. He began his career with the company at the age of 12 on January 2, 1902, as an apprentice in the Brooklyn shop two years after the Mack brothers built their first gasoline-propelled motor vehicle. At 18 he became a service engineer—work he was to continue until retirement. About 1910 he opened the industry's first driver training school in a rented garage in New York City. This instruction was essential for drivers who until then "gassed up" for the day's run with oats and bales of hay.

New Indian Stamp Series Features Caterpillar Tractor

The three pies stamp in a new series recently issued by India features a Caterpillar D4 tractor pulling a plow. The 18-stamp series has been designed to highlight the Indian Government's five-year plan. The three pies stamp is the lowest denomination of the series. The rest, including four air mail stamps, depict other scenes which express the effort of the people to build a new India.

This is the second time recently that a Caterpillar crawler tractor has been featured on a nation's stamp. In 1954, the Bahamas issued a one-penny stamp on which was reproduced a Cat D8 tractor mounted with a Fleco root rake and pulling a Rome disc plow.

Plan General Motors Show

Planning a giant show of diesel and aircraft power are Harlow H. Curtice, left, president of General Motors, and C. R. Osborn, vice president in charge of GM's Engine Group. Here they inspect a scale model of "General Motors Powerama," outdoor exposition scheduled for August 31-September 25 in a million-square-foot site on Chicago's lakefront. In addition to varied entertainment, Powerama will feature machines and other equipment produced or powered by GM's diesel, aircraft and heavy equipment divisions.

Benton Named Manager Of TCI Sales Division

Appointment of Thomas W. Benton as manager of the Sheet and Strip Products division of the Sales department of United States Steel's Tennessee Coal & Iron division has been announced. He advances from the position of TCI manager of sales, Memphis district.

A. R. Baldwin's appointment as manager of the merchant products division of TCI sales also has been announced. Baldwin formerly was manager of the Sheet and Wire Products division, which will be supplanted by the two new divisions of the TCI sales department.

Benton will be succeeded at Memphis by J. G. McCleery, presently TCI manager of sales, Charlotte, N. C., district. Going to Charlotte as district manager will be D. E. Nolen, now a TCI salesman assigned to Tampa, Fla.

Nordberg Manufacturing Moves Two Men to New Positions

Appointment of Louis C. Rove as district manager of the Great Lakes territory and transfer of William C. Young from that territory to Industrial and Petroleum Sales has been announced by Nordberg Manufacturing Company.

Rove, who will serve Michigan, Indiana, Ohio, western Pennsylvania and eastern Kentucky, began with Nordberg in the Engineering department 35 years ago. He has been serving as special representative, Heavy Machinery Sales, until this recent appointment.

Young joined Nordberg in 1940 as a cooperative student. After serving as sales engineer handling special assignments, Young was transferred to the Washington, D.C. office in 1951. In 1954 he was made Great Lakes district manager.

When your operations take you some distance from cities and towns, where will your employees live? Make them comfortable and happy with STURDYBILT Prefabricated Homes, close to the job.

Our variety of designs will suit the most discriminating families. Many size homes are also available, as well as duplexes and other multiple family units.

Ask about our purchase or lease plan.

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF CURTIS WOODWORK, JOHNS-MANVILLE BUILDING MATERIALS

STURDYBILT PREFABRICATED, DEMOUNTABLE HOUSES

SOUTHERN MILL & MANUFACTURING CO. • TULSA, OKLAHOMA

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

DIG....LOAD FAST!

Other attachments available include crane hook, street broom, angle dozer and bulldozer.

Working in combination with Hydro-Clam for digging spot excavations, the Loadmaster performs many labor saving jobs.

Extremely simple design with outstanding performance. This heavy duty industrial type loader has double acting, oversize hydraulic system. Raising height sufficient to clear average size trucks equipped with sideboards. Bucket capacity is 12 cu. ft. High down pressure enables digging and handling of tough, hard-packed material. Bucket roll-back is provided for handling loose material.

Bulldozer attachment measuring 66" x 24" is interchangeable with the bucket in a few minutes' time.

DIGS 12 FEET DEEP
SCOUT DITCHER

- ADAPTABLE TO MOST ALL TRACTORS!
- ELIMINATES NEED OF AN OVERDRIVE!

Ideal for projects where Fast Digging is required, the SCOUT 70 has extra speed, extra power, plus extra digging depth. Can be installed or removed from almost any tractor in approximately 20 minutes. Buckets for both rock and earth digging available in a variety of sizes.

AD #493

Write for additional information

SHAWNEE MANUFACTURING CO., INC.

1947 AX Topeka Ave. Topeka, Kansas

Stop Corrosion!

WITH *Harco* CATHODIC PROTECTION SYSTEMS

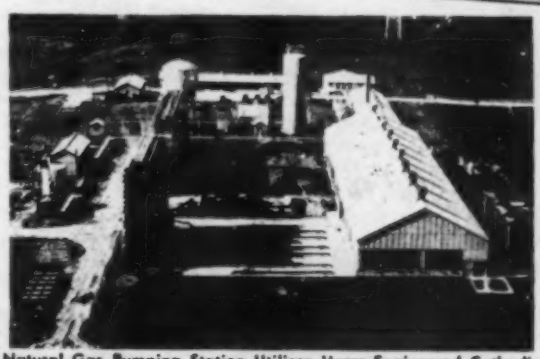
Industry's No. 1 Enemy can be stopped by HARCO.

Now there is a "police force" ready to help you in stopping thief corrosion. Harco engineers are defeating the ravages of electrolytic corrosion of underground and underwater piping.

HARCO JOB-ENGINEERED SYSTEMS provide necessary testing, drawings, materials, installation and maintenance.

HARCO INSTALLATION CONTRACTING is completed to customers specifications and covers as much of total job as required. HARCO will assist in evaluation and solution of your particular problems.

Stop the thief Corrosion Now!
Specify HARCO . . . FIRST IN THE FIELD OF CATHODIC PROTECTION.
Write today for catalog or call MOntrose 2-2080



Natural Gas Pumping Station Utilizes Harco-Engineered Cathodic Protective System to Eliminate Corrosion in Underground Lines

THE *Harco* CORPORATION *Cathodic Protection Division*

17019 Broadway • Cleveland, Ohio

6188-HC

Cleveland • New York • Chicago • Philadelphia • Detroit • St. Louis • Louisville • Minneapolis • Oklahoma City • Los Angeles • Seattle • Houston • Atlanta • Lynchburg • Pittsburgh • Albany • Davenport • Toronto, Canada

For more data on advertised products, use Readers' Service Cards, last page.

Assistant Superintendent Named At U. S. Steel's New Pipe Mill

Clyde W. Vassar has been appointed assistant general superintendent of the new expanded steel pipe mill near Provo, Utah, of U. S. Steel's Consolidated Western Steel division.

Other staff members at the mill, which commenced operations recently, are Walter E. Harris, chief plant engineer; Verne W. Thorpe, chief accountant—Utah; Don M. Northwood, supervisor of industrial relations; R. L. Carlson, Jr., supervisor of plant protection and safety; P. J. Pardini, material control foreman; O. S. Starks, maintenance superintendent; and John R. Basich, general foreman, large diameter mill.

Vassar formerly was with Western Pipe Company, one of the predecessor companies of Consolidated Western. He was transferred to the new Utah operation from Consolidated Western's Berkeley, Calif., plant where he was in charge of the pipe shop.

Harris, before his transfer to Utah, was plant engineer at the Berkeley Plant of Consolidated Western. Thorpe transferred to Consolidated Western from the Geneva Works of U. S. Steel's Columbia-Geneva Steel division, where he served as accounting supervisor for the blast furnace and open hearth accounting departments.

Northwood, another veteran of Western Pipe Company, started with that Company in 1922 as a timekeeper. He has been engaged in industrial relations work for Consolidated Western since 1948. Carlson joined Western Pipe Company in 1942 and before his transfer to Utah was wage administration supervisor for Consolidated Western in San Francisco.

Basich went to work at the south San Francisco plant of Western Pipe in 1939 and was supervisor of welding there. Pardini has 32 years of service with Consolidated Western Steel and predecessor companies. He has worked through many jobs in the division, and was material and traffic supervisor at the Berkeley plant prior to coming to Utah. Starks transferred to the Utah operations of Consolidated Western from the Orange, Texas, pipe plant, where he was assistant maintenance superintendent.

Cooper-Bessemer Assigns Field Engineer to Tulsa

The assignment of Donald E. Dixon to Cooper-Bessemer Corporation's Tulsa office as field engineer has been announced. He will devote his activities to both application and sale of engines and compressors for service on pipe line transmission for petroleum and chemical processing in the Oklahoma area.

Donald E. Dixon

Prior to his appointment, Dixon was manager of the compressor section, Sales department, at Cooper-Bessemer's plant in Mount Vernon, Ohio.

ARCCO
ARCCO-Anubis
LIQUID GRAVITOMETER
For PIPELINES, REFINERIES, GASOLINE PLANTS
NOW 19 MODELS
MODEL R
This ruggedly built instrument of laboratory accuracy is ideal for quick checking and for continuous recording of Specific Gravity of liquids under line pressure. Changes in Specific Gravity of sample are recorded with a very minimum of time lag. Foreign liquids and gases are automatically purged from sample. No moving joints or stuffing boxes to cause friction or leakage. Temperature corrected, this precision instrument is adaptable to high pressures. Hundreds are in daily use in plants and refineries of major companies. Available in 19 Models for Recording, Signalling, Transmitting and Controlling. Send for Bulletin 111R-3.
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RECORDING CHART CO.
3113 E. 11th St. • Los Angeles 23, Calif.
AVAILABLE FOR EARLY DELIVERY
SEND FOR BULLETIN NO. 111R-3

NEW BOOKS

1950-51 BIBLIOGRAPHIC SURVEY OF CORROSION, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2. $10 to NACE members; $12.50 to non-members.

More than 4400 abstracts and 4000 authors are classified and indexed in the 1950-51 Bibliographic Survey of Corrosion, the fourth of a series of bibliographies published by NACE. The others are 1948-49, 1946-47 and 1945. Each volume includes abstracts of corrosion literature published in the indicated years, classified according to the NACE's abstract filing system and including both alphabetical subject and author indices. The four volumes contain 12,414 abstracts made available to the association by more than 30 abstracting agencies.

ORIFICE METERING OF NATURAL GAS, GAS MEASUREMENT COMMITTEE REPORT NO. 3, American Gas Association, 420 Lexington Avenue, New York 17, N.Y. $2.50.

Covering recommendations relating to the use of certain types of orifice meters for measurement of natural gas, this manual supplements Report No. 2, first published by the A.G.A. in 1935.

Generally, all data in the report are similar to those included in Report No. 2, with the addition of new data based on extensive research carried on by the A.G.A. and others since 1948. This includes material on larger diameter and heavier wall thickness metering runs, details on specifications and tolerances of orifice metering installations, and a method of evaluating supercompressibility factors.

The pressure base for the basic orifice factors has been changed from 14.4 to 14.73 psia; however, a table is included which expedites the computation of gas flow in terms of a contractual pressure base.

Something New Again
in the LUFKIN LINE – Model TOF (C)

a combination self-loading float and pipe trailer ...

FOR OILFIELD, MACHINERY & HEAVY HAULING TRUCKERS

Get TWO (2) LUFKIN Trailers for little more than the price of ONE (1)

LUFKIN STANDARD MODEL TOF SHOWN WITH ALL OILFIELD SELF-LOADING FEATURES—READY TO BE USED FOR ANY HEAVY DUTY HAULING WHEN FLOAT IS REQUIRED. NOTE—LANDING GEAR FOLDS COMPLETELY UNDER TRAILER AND DOES NOT INTERFERE WITH LOADING OPERATION.

NOSE OF TRAILER IS TILTED FORWARD—BALANCED ON LANDING GEAR—4 PINS ARE REMOVED AND RUNNING GEAR EASILY PULLED BACK BY 1 MAN.

PIPE TRAILER IS COMPLETELY DETACHED FROM FLOAT BED AND READY FOR BOLSTERS, COUPLING POLES, ETC., FOR PIPE HAULING OPERATION.

BOLSTERS AND POLES INSTALLED ON PIPE TRAILER IN A FEW MINUTES.

NOTE: FOUR (4) STEPS ARE REVERSED IN SHORT ORDER TO RE-CONVERT TO FLOAT TRAILER.

HERE ARE THE ADVANTAGES OF THE LUFKIN MODEL TOF (C)

1. **IT'S SAFE—IT'S CONVENIENT**
2. **IT'S CHEAPER—TWO (2) TRAILERS FOR PRACTICALLY THE PRICE OF ONE (1)**
3. **IT'S AVAILABLE—AS A FLOAT OR PIPE HAULER—(2 MEN CAN MAKE CHANGE-OVER IN APPROXIMATELY 30 MINUTES**
4. **ONLY EIGHT (8) TIRES ARE PURCHASED AND MAINTAINED AS AGAINST SIXTEEN (16) WHEN 2 COMPLETE TRAILERS ARE PURCHASED.**
5. **ONLY ONE INSURANCE POLICY IS REQUIRED—IT'S STILL CHEAPER.**
6. **ONLY ONE (1) LICENSE PLATE IS REQUIRED—IT'S STILL CHEAPER.**

You can't GO WRONG with the LUFKIN TOF (C) if you want economy, less maintenance, lower cost and more service.

CALL YOUR NEAREST LUFKIN MAN FOR COMPLETE DETAILS

LUFKIN TRAILERS

DIVISION OF **LUFKIN FOUNDRY & MACHINE CO.**

FACTORY: LUFKIN, TEXAS • Phone 3-4425

BRANCHES AND SALES OFFICES { HOUSTON • DALLAS • ODESSA • SWEETWATER • WACO
CORPUS CHRISTI • SAN ANTONIO • LUBBOCK • SHREVEPORT

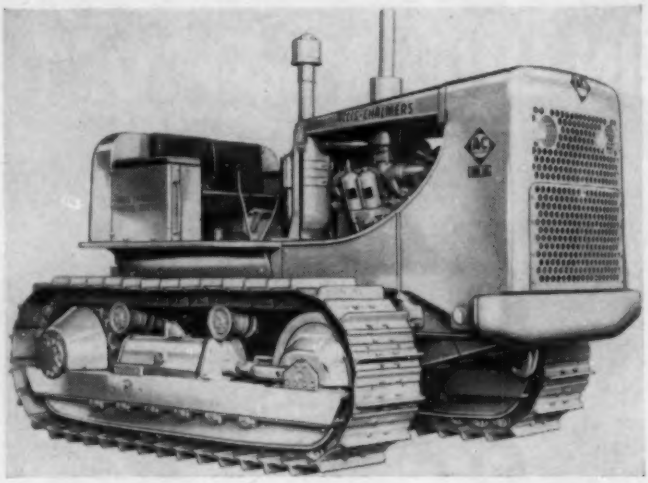
For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment

for the Pipe Line Industry

Diesel Crawler Tractor

The new Allis-Chalmers 31,500-pound HD-16 crawler tractor has a 6-cylinder, 844-cubic inch diesel engine which develops 150 net engine horsepower at 1800 rpm with torque converter and 140 net engine horsepower at 1600 rpm with standard transmission.



Maximum drawbar pull of 60,000 pounds is obtained with torque converter drive. The standard transmission tractor has a maximum drawbar pull of 31,700 pounds at rated engine speed. Under overload, the engine torque increases, resulting in additional drawbar pulls up to 35,945 pounds at reduced travel speed.

New features of the tractor include wrap-around radiator guard which tilts forward and down for easy accessibility; Allis-Chalmers diesel engine and matched torque converter power team; long-life ceramic master clutch lining; newly-engineered power train with correct gearing for developing the high drawbar pulls plus big reserve capacity to provide maximum productive hours on the job.

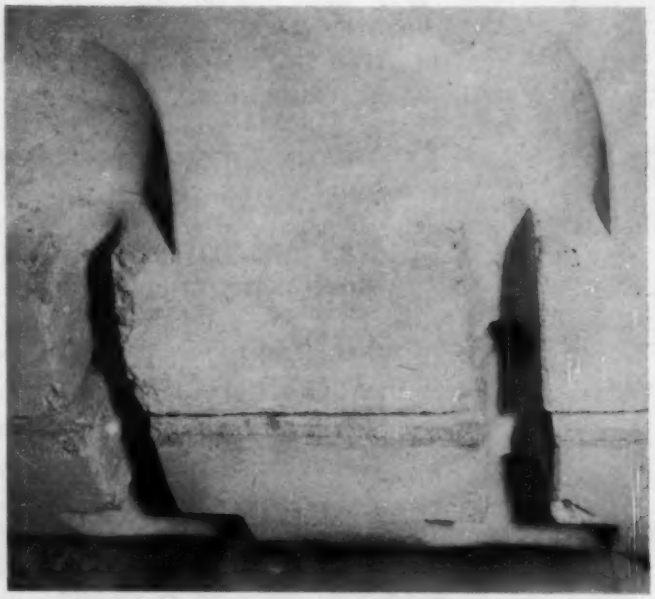
A new line of matched equipment such as dozers, shovels, scrapers and sideboom is designed especially for the HD-16. The new radiator guard reduces the cost of tractor-dozer packages because the hydraulic rams or cable-lift sheaves mount directly on it, eliminating the need for a separate dozer lift frame.

(This item supplements Allis-Chalmers Manufacturing Company data on Pages 168-169 of the Composite Catalog, 20th Edition.)

For more data circle **No. E1** on Readers' Service Card, last page this issue.

Concrete Weights

The Anchor-Wate Company has announced a line of bolt-on type concrete weights designed with T-type slots for fast alignment on the line.



Concrete halves are hinged with wire cable line embedded in the concrete when the "Wates" are cast. When picked up, the halves open so they can be lowered onto the pipe line without difficulty, eliminating time and trouble of placing concrete weights on top and bottom of the line and the numerous bolts required to hold them together on the pipe. The two halves automatically fold around the pipe until they are in position.

Two men can make this installation, one on a side boom and another to place and tighten bolts. Installation operation requires about half the time necessary to place ordinary concrete weights on a pipe line. The bolt fits into a slot in each half of the Wate, eliminating necessity of lining up. The galvanized cable hinge used on the Wates is corrosion and rust-proof.

For more data circle **No. E2** on Readers' Service Card, last page this issue.

Safety Coupling

Pipe Line Development Company recently announced production of 72-inch Weld + Ends safety couplings for use on gas lines. The couplings are designed to rejoin pipe lines securely so that flow can be resumed immediately at full pressure even before welding. They may be used for working pressures up to 2000 psi in smaller sizes. The use of Weld + Ends saves shutdown time and costs, reduces product losses and cuts maintenance and labor costs. In addition, final welding can be performed while the line is in use days or weeks later.

(This item supplements Pipe Line Development Company data on Page 4149 of the Composite Catalog, 20th Edition.)

For more data circle **No. E3** on Readers' Service Card, last page this issue.

Heavy Equipment Axles

For application in heavy duty, four-wheel drive equipment such as graders, scrapers and other off-the-road vehicles, Clark Equipment Company's Axle division is offering a new line of planetary drive and drive-steer axles.

The drive-steer axle is available in 11,000, 17,000 and 20,000-pound capacities. Of similar design, the companion line of drive axles is available in 16,000, 17,000, 24,000 and 30,000-pound capacities. By replacing the conventional differential carrier with a through-drive type, the smaller axles in this line can be converted into tandem units.

All shafts are alloy steel, heat-treated for maximum strength. Gears are forged alloy steel, case hardened and heat-treated to withstand heavy shock loads and to provide long life. Extra heavy tapered roller bearings are used and rigidly mounted in adjustable cases to provide and maintain gear positions. The axles have range of capacities, flexibility of ratios and interchangeability of carrier assemblies.

For more data circle **No. E4** on Readers' Service Card, last page this issue.

Blast Hole Drilling Unit

Ingersoll-Rand's new triple duty drillmaster is a self-contained drilling unit designed to speed up drilling of rock and provide a range of hole sizes and drilling depths not available before in a blast hole drill.

The drillmaster embodies three combinations or methods of drilling: It utilizes a new Depth-Master or "down the hole" drill for deep blast holes up to six inches in diameter; it is available with the Power-Master, a new heavy-duty hammer drill, for 4¼-inch holes; and, with the Roto-Master rotary drill, it can be used for rotary drilling of holes up to 6¼ inches in diameter. One or all three of the drilling

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

YOUNGSTOWN LINE PIPE EASY TO WELD

● Talk to your welder about this advantage. He will tell you that Youngstown A.P.I. Electric Weld Line Pipe has good, clean, consistent beveled ends, uniform wall thickness and diameter. This means the ends line up well. Control of chemical composition is designed to permit maximum weldability. These factors result in faster installation and lower costs to you.

SPECIFY QUALITY V YOUNGSTOWN SERVICE

ELECTRIC WELD **LINE PIPE**

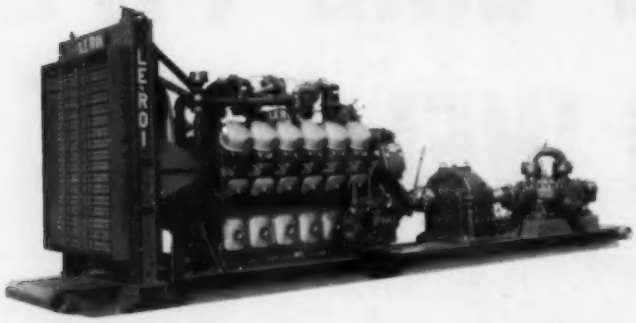
THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices: Youngstown 1, Ohio • Export Office: 500 Fifth Avenue, New York 36, N. Y.

For more data on advertised products, use Readers' Service Cards, last page.

Powerful LeRoi-Goulds Pumping Unit for forming underground storage.



Unitized by Southern Engine & Pump Company for a natural gasoline company to these specifications:

ENGINE: LeRoi Model L-3460 Natural Gas Engine 7¼ x 7

PUMP: Goulds Figure 3360 Size 3" 6-stage equipped with Crane Mechanical Seal

BASE: 44" x 26' consisting of 10" main members

DUTY: 450 GPM—700 PSI—Fresh Water 900 RPM Engine Speed—3600 RPM Pump Speed

Such a unit is typical of many done by us during 47 years of service to industry. Skilled mechanics and competent engineers are available to serve your special needs.

DISTRIBUTOR

SOUTHERN ENGINE & PUMP COMPANY

MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

Houston — Dallas — Kilgore — San Antonio — Edinburg — Corpus Christi and Beaumont, Texas — Lafayette and New Orleans, La.

STANDARD OF THE INDUSTRY . . . for cutting steel or cast iron pipe . . .

THE

ALSTON *Rachet* **PIPE CUTTER**

There's none better for SPEED, SAFETY, POWER, ACCURACY and ECONOMY. It eliminates dangerous sparks . . . broken cutters; rollers hold pipe taut after cutting. It's easy on and off pipe . . . will cut 10" pipe in 12 min. Patented roller guides. Rachet makes it easy to work in close places.

A size for every requirement . . . write for details, literature and prices.

ALSTON MANUFACTURING COMPANY

P. O. Box 707 Phone 226

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H. B. ZACHRY CO.

General Contractors

PIPE LINE DEPARTMENT TRANSIT TOWER

SAN ANTONIO, TEXAS

Phone: CApitol 6-2472

Skill, Integrity and Responsibility

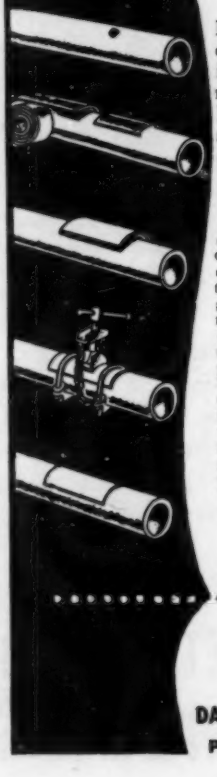
Constructors of

PIPE LINES

Oil Field Stations Electrical Installations

NOW! Fits Up to 30" CASINGS

TO STOP PIPE-LINE LEAKS *Simply-Quickly*



DALLAS GRO-CORD GASKETS now offer the complete pipe-line gasket service. Formerly up to 10", GRO-CORD'S new stock is now made UP TO 30 INCHES in two sections—flat and crown stock plied together to insure safe, extra-tight sealing.

Easy to Apply . . . They Last for Years

(a) Regardless of size of leak, just cut GRO-CORD gasket to cover generously . . . (b) Cut a piece of plate (half sole or sleeve) to extend about 1" on both sides and ends of gasket . . . (c) Fit plate over gasket so as to extend beyond gasket on all sides . . . (d) Clamp repair tight with a chain jack to shut off the leak . . . With clamps, hold plate in contact with pipes at all points. Weld all around and REMOVE CLAMPS. GRO-CORD gaskets have been in service up to 5 years before permanent or final weld was made. Tested at 1600 lbs. p.s.i., oil resistant, cotton impregnated GRO-CORD gaskets last for years. 15 years exclusive use by major gas distributing company. Write for literature.

DISTRIBUTED BY:

OILWELL SUPPLY
Division of United States Steel Corp.
IVERSON TOOL COMPANY—Tulsa, Okla.

Jobber Inquiries Invited. Write for Folder PE-11

DALLAS GRO-CORD PIPE REPAIR GASKETS

DALLAS MANUFACTURING & SALES COMPANY

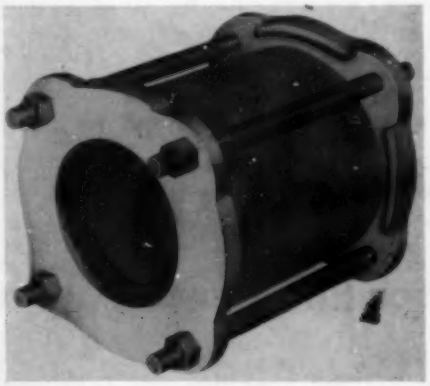
POST OFFICE BOX 7181 DALLAS 9, TEXAS

combinations are available to fit requirements or rock conditions.

Additional features included in the new Drillmaster unit include a tower, providing long steel changes; positive chain feed, a dust collector and rotary compressor; a motor-driven crawler assembly and others.

(This item supplements Ingersoll-Rand data on Pages 2411-2418 of the Composite Catalog, 20th Edition.)

For more data circle **No. E5** on Readers' Service Card, last page this issue.



Adaptor Coupling

A new corrosion-resistant line pipe adaptor coupling, designed to reduce field inventories while increasing installation convenience, is now available for use on lead lines, salt water lines, water flood systems and fresh water systems.

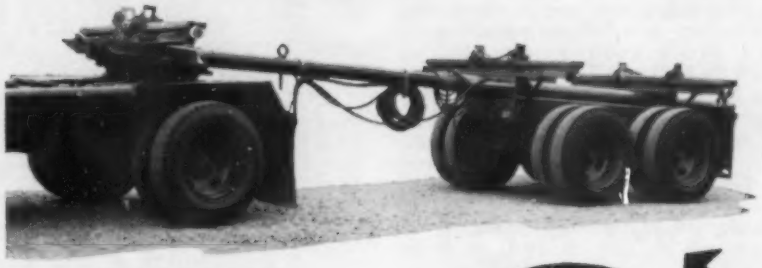
Easily installed and dismantled, Johnson-Fagg Engineering Company's new Little Giant adaptor coupling fits a variety of pipe classes and materials. It will join cement asbestos (all classes in the same size); cement asbestos to steel; steel to steel and plastic to steel.

The coupling has cement asbestos body and high strength iron flanges. Seal is accomplished by pressure against oil resistant synthetic rubber gaskets between flanges and body. It is available in straight sizes of 3 to 12 inches and in reducers of various sizes.

(This item supplements Johnson-Fagg Engineering Company data on Pages 2514-2515 of the Composite Catalog, 20th Edition.)

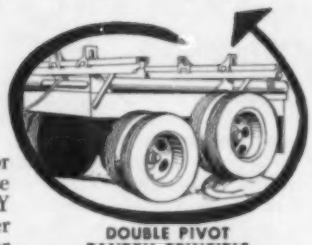
For more data circle **No. E6** on Readers' Service Card, last page this issue.

TOP QUALITY PIPELINE TRAILER



THE LOADCRAFT

PIPELINER



DOUBLE PIVOT TANDEM PRINCIPLE

At last here's a top-quality tandem trailer for the pipeline industry that is really built to take the cross-country hikes. The axles will STAY in alignment. Quality that has made Spencer Trailers popular with the oil fraternity for over 38 years goes into each of these jobs.

Double pivot tandem keeps load in balance in rough terrain, reduces wear and tear on axles and tires Hi-tensile pressed steel frame, wood surface block-type bolster plus other exclusive features gives you the kind of trailer you have needed ..and at a price that is less than you would expect to pay for such high quality.

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GOTKOOL Water Can—made in 1½, 2, 3, 5, 10, 15, and 20-gallon sizes without faucets. Extended or recessed flush-mounted faucets available at slight additional cost. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

GOTKOOL Water Cooler—made in 2, 3, 5, 8, 10, 15, and 20-gallon sizes with extended or recessed flush-mounted faucet optional. *(Note: 15- and 20-gallon sizes available with extended faucet only.)*

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Field Lubrication Service

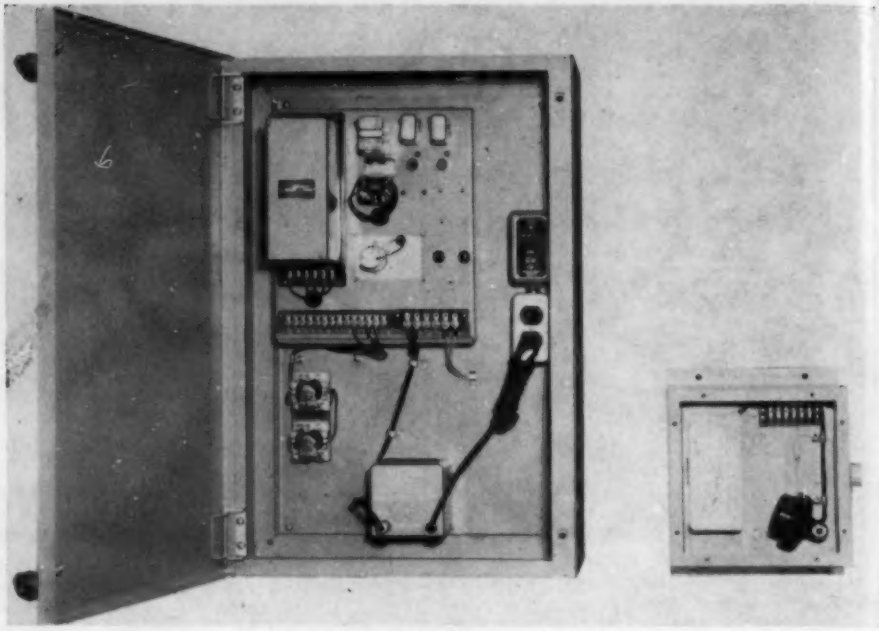
Oil field installations and refineries, pipe lines and other users of Rockwell-Nordstrom plug valves can now contract for a comprehensive field lubrication and maintenance service under a new plan announced by Rockwell Manufacturing Company's Meter and Valve division.

The new service is designed to bring complete lubrication and maintenance service facilities to Rockwell-Nordstrom valve users by means of a fleet of specially built one-ton trucks. A company can choose any one of a number of contractual arrangements to suit its own particular needs.

The specially constructed trucks that provide the service carry complete field stocks of valve lubricants, lubrication fittings, lubricant pumping equipment and spare parts. To facilitate standard maintenance and field service, the trucks are equipped with tool benches and a sliding roof for adequate light and ventilation. A 7½ hp gasoline-driven compressor provides power for the pneumatically-operated lubricating guns and other air tools. A hose reel is available for remote lubrication of valves where safety regulations force the truck to remain at a distance.

While these trucks were specially built to provide service for Rockwell-Nordstrom valves, the service men manning the trucks are able to provide service for other Rockwell products as well.

For more data circle **No. E7** on Readers' Service Card, last page this issue.



Monitor and Control Unit

A remote monitor and control unit for unattended pump stations is now being manufactured by Nelson Electric Manufacturing Company. With this unit a pipe line dispatcher, by use of existing telephone facilities, may make audible contact with a pump station to determine operating status of the pumping unit, or he may start or stop the pump motor.

The unit is easily installed on present telephone lines and may be used for up to 125 stations on one pair of lines. The unit avoids the delay and expense of manual operation, allows the dispatcher to immediately start or stop any station when necessary and has a very low maintenance cost.

For more data circle **No. E8** on Readers' Service Card, last page this issue.

You can save from ½ to ⅔ the cost of a new gauge, or instrument, by using our complete overhaul and repair service. Quality, guaranteed work. Fast service.

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AND
INSTRUMENT CO.
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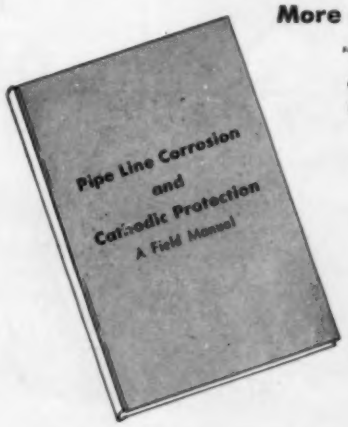
More comments on this new Handbook:

"... a most practical on-the-job manual for men concerned with pipe line corrosion. We are ordering copies for each of our district engineers."



Pipe Line Corrosion and Cathodic Protection

By MARSHALL E. PARKER

This Handbook, written by Marshall E. Parker, consultant, is designed as a practical field manual. It is a 108-page pocket-size volume printed first as a popular series in WORLD OIL. The Handbook is illustrated with many charts and drawings and is completely indexed by subjects.

It presents comprehensive data on Soil Resistivity Surveys, Potential Surveys, Line Currents, Current Requirements, Rectifier Systems, Ground Bed Design, Magnesium Anodes, Stray Current Electrolysis, Interference in Protective Systems, Operations and Maintenance, and Coating Protection and Testing.

An appendix has been added of technical data on Underground Corrosion, Basic Principles of Cathodic Protection, Properties of Metals and Attenuation Equations. Order copies of this practical Field Manual now for each of your field men. Price $3.

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New Equipment Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

Sling Chain Catalog

A complete catalog of Herc-Alloy sling chains has been published by Columbus McKinnon Chain Corporation. Well illustrated, it includes specifications, uses and general data on all types of chains available from the company. Sections on how to order sling chains, care, use and inspection of Herc-Alloy sling chains, and specifications and descriptions of all types of hooks, links and rings available are included.

To get a copy circle **No. E9** on Readers' Service Card, last page this issue.

Portable Oil Filter

In a new bulletin, The Hilliard Coporation introduces a portable line of Hilco Hyflow oil filters. Discussion of oil maintenance ability of the filters, lists of uses, illustrations of specific models and general data are included.

Also in the bulletin are information, illustrations and references concerning combination portable Hilco Hyflow oil filters-Hilco oil reclaimed units ideal for filtration and vacuum vaporization of water and other volatile contaminents on turbines, diesel and gas engines, transformers, gear drives and hydraulic oils.

To get a copy circle **No. E10** on Readers' Service Card, last page this issue.

Expansion Joint Booklet

"ExpandZorber," a line of flexible pipe connections used to solve vibration and expansion control problems in industrial and process piping, is described in a catalog recently released by T. R. Finn & Company, Inc.

The stainless steel, welded diaphram-type, packless expansion joint described in the catalog is widely used for absorption of vibration, expansion and contraction in steam, chemical, oil and gas lines.

The catalog describes pressure and temperature ranges of application, lists dimensions and specifications, as well as illustrating the various types of special-purpose joints available. Complete selection factors and installation procedures are also given.

To get a copy circle **No. E11** on Readers' Service Card, last page this issue.

Cooling Control Data

A data sheet containing cross-section drawings and specific information on the Type T-44 cooling control has been published by Sarco Company, Inc. Perforated, it is designed to supplement a recent bulletin on cooling controls with remote bulbs and larger capacities.

Design features, operation, construction, temperature adjustment ranges and capacities of the T-44 control are given, plus typical hook-up sketches for various installations.

To get a copy circle **No. E12** on Readers' Service Card, last page this issue.

Centrifugal Compressors

A new bulletin on centrifugal compressors for natural gas transmission has been announced by Worthington Corporation. A two-page diagram is used to illustrate 13 major design features of the centrifugal compressor with centerline support.

Information is presented on these compressors driven by gas turbine, internal combustion engine, electric motor or steam turbine. An outline drawing is also presented along with information on the lubricating and sealing system.

To get a copy circle **No. E13** on Readers' Service Card, last page this issue.

Cathodic Protection Data

Publication of a series of technical reprints on cathodic protection and how it works against corrosion has been announced by Corrosion Rectifying Company. Written by Wayne A. Johnson, president of the company, the articles include detailed information about the problem of external corrosion of flow lines laid in salt water and moist land and how complete protection was provided.

"How to Combat External Casing Corrosion," "Pipe Line Leaks Are Not Inevitable" and economics of cathodic protection are among other articles included in the series.

To get a copy circle **No. E14** on Readers' Service Card, last page this issue.

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☆ ☆ ☆

All in all, the new Allis-Chalmers HD-16 brings you an outstanding combination of performance and long life with both mounted and drawn equipment . . . a higher rate of production, more working time, more work done, LOWERED JOB COSTS.

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